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ABSTRACT

A needs assessment of the Grumman E-Beam Systems Group identified the requirement for additional skill mastery for the engineers who assemble, integrate, and maintain devices used to manufacture integrated circuits. Further analysis of the tasks involved led to the decision to develop interactive videodisc, computer-based job aids to enable mastery of the tasks. A training program was designed to enable more efficient use of the job aid. One module was fully developed and implemented. Acceptance of the computer-based format, as well as the technical accuracy of the job, were evaluated. Following the methodology established by the Interservice Procedures for Instructional Systems Development, the analysis, design, development, implementation, and evaluation phases are discussed. Additionally, the many design decisions, and the research supporting those decisions are discussed in depth. Included are considerations of modern cognitive and behavioral psychology, as well as media and simulation fidelity analysis. Supporting information is provided in 13 appendices, and a 30-item bibliography is provided. (Author/DB)

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FACILITATING INTEGRATION OF ELECTRON BEAM LITHOGRAPHY DEVICES WITH INTERACTIVE VIDEODISC, COMPUTER-BASED SIMULATION AND JOB AIDS

by

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B.S. 1987, New York Institute of Technology
A.A.S. 1979, State University of New York at Farmingdale

A Thesis/Project

submitted to The Faculty of the

School of Media and Arts

of the New York Institute of Technology in partial satisfaction of the requirements for the degree of

Master of Science

26 April 1990

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Final Examination

of

Robert C. Von Der Linn

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Facilitating Integration of Electron Beam Lithography Devices with Interactive Videodisc, Computer-Based Simulation and Job Aids

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Thursday, April 26, 1990 at 9:00 a.m.

in

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Old Westbury Campus
Old Westbury, NY

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ROBERT CHRISTOPHER VON DER LINN

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of

NEW YORK INSTITUTE OF TECHNOLOGY

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

TRAINING AND LEARNING TECHNOLOGY

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CHAPTER 1

INTRODUCTION

Overview

The difference between desired behavior and actual behavior is, in a general sense, the definition of a need. Within the world of organizational development, the number of possible ways to address this need is large indeed. Many factors are weighed while analyzing the numerous means to eliminate this need. The goals of the organization, both long and short term must be considered. The impact that the various solutions may have on personnel from morale to staffing levels, has to be examined. The cost of development for each of the possible solutions must be weighed against anticipated return on investment. The time required to implement a particular solution must be balanced with the urgency to eliminate the need. The Instructional Systems Development Group of Grumman Simulation/Trainer Products, of which the designer is a part, was asked to find a solution to such a need. The problem was to find a way to facilitate more efficient integration of Electron Beam Lithography (EBL) devices at Grumman's Great River Operations (GRO) center, and increase efficiency of manufacturing operations at IBM's Advanced Systems Technology Center in East Fishkill, N.Y. The result of the request was an interactive computer-based job performance aid and a training demonstration module. This document chronicles the development of the job aid and training module. The choices faced by the designers, the decisions they made, and the supporting reasons for the decisions are thoroughly discussed.

Background

Lithography can be described as the process of using a tool to make multiple copies of a pattern or print. The application being referred to in this document is the process of manufacturing integrated circuits. In the 1960's, IBM scientists invented a process known as electron beam lithography. This process was initially used to make optical masks for the more conventional photo-chemical etching process, making major improvements in that process. By 1976, electron beam lithography was being used to write wafers directly, replacing the optical method. "Electron beam (e-beam) lithography has played an important role in the advancement of the science and technology of very small semi-conductor and metal device structures" (Pfeiffer, Groves, Newman, Hohn, 1988). The current e-beam system, known as the EL-3, features higher resolution and increased writing speed over its predecessors, the EL-1 and EL-2. Today the thrust of development in e-beam lithography is increased throughput for manufacturing (Pfeiffer, et al., 1988). Under contract to IBM for the manufacturing and integration of the e-beam lithography systems is the Grumman Corporation of Bethpage, N.Y. The integration of the EL-3 systems is the responsibility of the Grumman Corporation's Electronics Systems Division (ESD), E-Beam Systems Group located at Grumman's Great River Operations (GRO) facility. Once the components of an EL-3 system have been integrated and tested at Great River, the system is shipped to IBM in East Fishkill, N.Y. More than thirty IBM EBL devices exist for purposes of research and production

(Pfeiffer, 1988). At East Fishkill, Grumman Technical Services, under contract to IBM, maintains a staff of more than fifty, whose sole purpose is the technical support of the e-beam devices. To maintain the high manufacturing standards required for making integrated circuits at IBM, the technical support staff must perform daily and weekly checks of the EBL devices. IBM realized that the cost of this support could be reduced. Similarly, Grumman management realized that several jobs being performed by the e-beam systems integration team had become highly specialized. A situation had evolved where certain key personnel were the only ones with functional knowledge of the system for which they were responsible. If one of these people were unavailable to work, for whatever reason, the delivery schedule could be severely impacted. This problem is compounded by the fact that each of the EBL devices built to date is essentially unique and a new generation of e-beam systems, the EL-3+, was beginning. Starting with e-beam device serial number 27, on which this project is based, there was the intent for a standardized configuration through the next six devices. In April, 1988, IBM approached Grumman ESD informally for ideas as to how they might increase system "up-time," or availability, of their e-beam systems at their East Fishkill, N.Y. manufacturing facility. The management of ESD turned to the Simulation/Trainer Products (S/TP) group for suggestions and a preliminary analysis. A training program was suggested by S/TP that employed an interactive videodisc, computer-based training (IVD/CBT) system. A brief videotape that described the proposed system was sent to

IBM. The proposed system would serve a dual function; first, as a primary training system and second, as an on-line diagnostic job aid. In January, 1989, IBM formally sent a Request for Proposal to Grumman ESD with a list of jobs performed by e-beam engineers that they had targeted for training. IBM agreed that an IVD/CBT system was appropriate but wanted assurances of adequate return on investment (ROI) recognizing that the cost of development for IVD/CBT can be very high. Grumman ESD felt confident that a significant ROI could be demonstrated. In April, 1989, a contract was negotiated whereby the development cost of a prototype system was split between Grumman and IBM. The first system would be utilized by Grumman personnel who could use the system during future EL-3+ systems integration. Grumman would supply the subject matter experts and the EL-3+ device. Grumman would demonstrate the system to IBM, at which time IBM could contract for additional development work if desired.

The operation and maintenance of the EBL devices is a job of extreme importance to IBM. To keep the production rate high and perhaps increase it, IBM was investigating ways to improve production efficiency. Training is obviously one possible way. Similarly, Grumman realized that maintaining a tight delivery schedule at a profit requires efficient integration of the EL-3+ systems. Both organizations sought a solution to this need.

Statement of the Problem

There are two organizations with similar problems being addressed during the course of this project. Chronologically, the Grumman problem had to be dealt with first. EBL device number 27 is the first of a new generation e-beam system, the EL-3+. Grumman was under contract to integrate and deliver six more in addition to the prototype. The exact procedures for integrating the system were being established for the first time. Grumman wanted to document the integration process, as it was established, and have that documentation available to the engineering staff for the integration of the next six. IBM was faced with a similar problem. The manufacturing operations at IBM require e-beam systems technical support staff to perform daily and weekly checks of the system. These tasks require a highly experienced staff that performs both accurately and efficiently. Training and maintaining this staff adds to the overhead costs of manufacturing. IBM was looking for a way to reduce its manufacturing costs and increase its productivity. Additionally, both organizations identified a need to bring future new-hire technical staff up-to-speed on the EL-3. The problem presented to Simulation/Trainer Products was to analyze the needs of the Grumman E-Beam Systems group and develop a solution to eliminate them. The designers had to keep in mind that a secondary goal of the project was to receive a follow-on contract to develop additional training for IBM.

Purpose of the Project

The e-beam systems training project was of major importance to many people for many different reasons. To Grumman Electronics Systems Division, the project meant cooperation between two of its sub-units, an expanded business base and the potential for profit. To the E-Beam Systems group, the project meant they would get a tool to help maintain the production integration schedule for the EL-3+ devices. To IBM, the project represented a possible means to increase manufacturing efficiency. For Simulation/Trainer Products, the project represented a new area of business outside of the military simulator world and the possibilty of follow-on contracts. To the S/TP ISD group, the project had significance as well. For them, it was a stepping stone to more ambitious training programs. The ISD group was gaining expertise in the development of IVD/CBT that would lead to more cost-efficient development of future IVD/CBT projects, including work for IBM. But beyond that, this project was a big step up the learning curve towards the ability to produce interactive courseware for the military. Simulation/Trainer Products, at the time of this writing, was pursuing several contracts with the military involving the development IVD/CBT. The military specifications for training systems are stringent and to develop IVD/CBT to those standards profitably requires an organization that is both capable and prepared. The designers approached this project as though the military was the customer, to make the final step to full military standards easier.

Definition of Terms

Alignment Brightness FRU (ABF) - A component of an electron beam lithography deveice.

Branching - The decisions, or decision points where the lesson path changes due to software or the users response.

CBT - Computer-Based Training.

DVM - Digital Voltmeter.

Enabling Objectives - Sub-tasks that make up the Terminal Learning Objectives (TLO). In order to master a TLO, the component sub-tasks must be mastered.

Electron Beam Lithography (EBL) - The process of using an electron beam to make patterns on a silicon wafer.

EL-3+, EL-3 - Electron Beam Lithography Devices.

ESD - Grumman Electronics Systems Division.

FRU - Field Replaceable Unit.

ISD - Instructional Systems Development.

  1. The ISD group, part of Simulation/Trainer Products.
  2. The ISD process, a systematic approach to the design of instruction.

Interactive Videodisc (IVD) - A computer-based presentation system using a videodisc as a storage medium, where the sequence of the presentation is based on the users responses.

Job Performance Aid (JPA) - A tool designed to assist in the performance of a job task.

Job Performance Measures (JPM) - The conditions, observable behavior, and standards for each instructional objective.

ROI - Return on Investment - The financial results of a project and the cost of developing it.

SME - Subject Matter Expert.

Step List - A list of all the sub-tasks and the steps that must be performed in the execution of those sub-tasks in order to complete a Terminal Learning Objective.

S/TP - Grumman Simulation/Trainer Products Group.

Terminal Learning Objectives (TLO) - Tasks performed by job incumbents that must be mastered.

Assumptions

1. That the engineering staff at Grumman would use the system when it became available, instead of continuing to rely on the specific system experts.

Limitations

1. That the training module and job aid developed for the Beam Bring-Up procedures for EL-3+ device, serial number 27 are only applicable to that specific device. The training is not applicable to any devices with a lower serial number and may not be suitable for subsequent devices. An analysis of the procedures for any future application will be necessary before using this training. Application of this training and/or job aid to any EBL device other than number 27 may result in improper operation and/or damage to that device.

2. The job aid is designed to assist in the tasks performed on a fully operational system. It does not assist in diagnosing the problems of a faulty system.

3. The analysis phase had limitations placed upon it by the management of the electron beam lithography group. They had a production schedule to meet for the integration of EBL device number 27. The engineers who served as SMEs were needed to work on the device. Their time was critical and the ISD group was directed to make most efficient use of the SMEs availability.

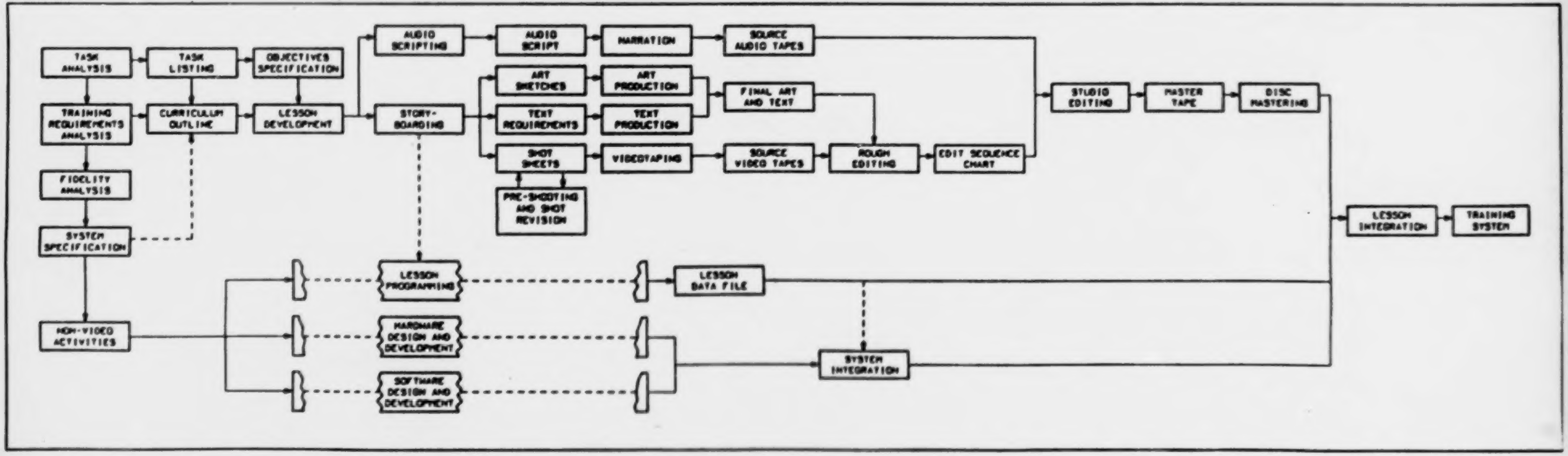
Methods and Procedures

The daily and weekly system calibrations performed by the IBM technical staff on the manufacturing systems are very similar to the daily and weekly readiness checks performed by military organizations on their weapons systems. Since one goal of S/TP is to develop training for military customers, the Interservice Procedures for Instructional Systems Development developed at Florida State University (1983) as implemented by the U.S. Army in TRADOC Pamphlet 350-30 "Interservice Procedures for Instructional Systems Development" are adhered to throughout. The Interservice procedures provide guidelines for a systematic, engineering-type approach to the development of training programs. This "systems approach to training" is a five-phase process that will, if adhered to, lead to educationally effective, cost efficient training. Each of the five phases; analysis, design, development, implementation, and evaluation are described in the next four pages. A flow diagram showing the sequence of events for developing a typical interactive videodisc computer-based training (IVD/CBT) system is shown in Figure 1. The delivery media was developed in accordance with the U.S. Army TRADOC Circular 351-88-1 "Interactive Courseware (ICW) Management and Development." Similarly, the job performance aid was developed in accordance with the U.S. Air Force Human Resource Labs' Technical Report 73-43, "Fully Proceduralized Job Performance Aids; Handbook for JPA Developers."

Analysis

The analysis phase encompasses the assessment of the organizational requirement for training. Why did the E-Beam systems group come to us for a training system? What is it that they are trying to do, that they feel training is the answer to?

FIGURE 1. FLOW DIAGRAM FOR A TYPICAL INTERACTIVE VIDEODISC COMPUTER–BASED TRAINING (IVD/CBT) SYSTEM PROJECT


TASK ANALYSIS
TASK LISTING
OBJECTIVES SPECIFICATION
TRAINING REQUIREMENTS ANALYSIS
CURRICULUM OUTLINE
LESSON DEVELOPMENT
FIDELITY ANALYSIS
SYSTEM SPECIFICATION
NON-VIDEO ACTIVITIES
AUDIO SCRIPTING
STORY-BOARDING
AUDIO SCRIPT
NARRATION
SOURCE AUDIO TAPES
ART SKETCHES
ART PRODUCTION
TEXT REQUIREMENTS
TEXT PRODUCTION
FINAL ART AND TEXT
SHOT SHEETS
VIDEOTAPING
SOURCE VIDEO TAPES
ROUGH EDITING
EDIT SEQUENCE CHART
PRE-SHOOTING AND SHOT REVISION
STUDIO EDITING
MASTER TAPE
DISC MASTERING
LESSON INTEGRATION
TRAINING SYSTEM
LESSON PROGRAMMING
LESSON DATA FILE
HARDWARE DESIGN AND DEVELOPMENT
SOFTWARE DESIGN AND DEVELOPMENT
SYSTEM INTEGRATION

The first part of the analysis phase involved a needs assessment. The designers observed the systems integration team as they worked on the EL-3+ system. Extensive interviews were conducted with all levels of the Grumman engineering staff; systems engineer through Director of E-Beam Systems. A comprehensive list of the tasks performed by the systems integration engineers was made. This list was reviewed by job incumbents and modified as required. It became apparent to the designers that training was only part of the solution. A large part of the problem could be solved by the development of job aids. Criteria were adopted for deciding which of these tasks were appropriate for training and which were appropriate for a job aid. Similar to a media selection model, the training/job aid selection model yielded a list of tasks appropriate for the job aid and a list of tasks appropriate for training. From the list of tasks appropriate for training, one was selected to be fully developed as an interactive training demonstration for IBM.

Design

Job Performance Measures were established for every task. For the training module the behavior, conditions, and standards for performance were defined. For the job aid, guidelines were established defining the necessary level of detail for implementation. Existing information on e-beam operational procedures was analyzed. The appropriate instructional setting for each task was determined. Entry skills, or prerequisite knowledge, was described. The sequence and structure of the tasks to be learned were established. A media analysis was conducted and the instructional delivery method was specified as computer-based interactive videodisc. The learning activities were specified based on both cognitive and behavioral theories. Storyboards and flowcharts describing the actual presentation of the information were created. A plan for assessing the ability of the system to enable mastery of the objectives and transfer that knowledge to the actual equipment was made. Similarly, a plan to evaluate the results of this program was made.

Development

The delivery hardware was procured, assembled, and tested. The authoring system was procured and integrated with the hardware. The designers followed the storyboards and flowcharts to create the actual presentation. The instructional materials were set up and a formative evaluation was conducted. The job aid and training module were modified as required for final delivery.

Implementation

A final version of the job aid and training module were delivered to the Grumman E-Beam systems group, and the management plan for implementation was initiated. This plan included a goal statement as to what was intended to be accomplished by the training, how the training was to be implemented, and how it was to be to determined if the goals were met. Material was distributed to gather data about the program and directions were included for steps to be taken in the event that the goals were not being met.

Evaluation

The evaluation process actually began at the start of the project and continued throughout, extending for the duration of its implementation. Every aspect of the project was continually evaluated and modified as necessary. Two formal evaluation phases were conducted. The first was a formative evaluation done during the development phase to determine if the job aid and training module met the learning objectives. The summative evaluation was conducted after the implementation of the system. The summative evaluation determined whether the program met the goals that the organization had set. The transfer of training from the learning environment to the working environment was also assessed. An attempt to quantify the impact on the "bottom line" of the organizations was also made at this time. Upon completion of the evaluation, recommendations were made for future consideration.

Summary

IBM and Grumman both identified a need within their respective organizations pertaining to the use of Electron Beam Lithography systems. Grumman Simulation/Trainer Products was asked to assess the situation and find a solution. An analysis was conducted and a program was designed and developed featuring an interactive computer-based job performance aid and training module. The effectiveness of the total system was evaluated for both impact on job performance and impact on the bottom line for both organizations.

CHAPTER 2

ANALYSIS

Introduction

To achieve any measure of success with this project, a thorough, accurate analysis had to be done. "This is perhaps the most critical phase of ISD, because it's here that the foundation is built for the remainder of the process" (Branson, Rayner, Cox, Furman, 1976). Consequently, a thorough and painstaking job was done from needs analysis to the design phase. Establishing precisely the need of the target organization is critical to any training program. For our purposes, need was defined as the discrepancy between observed performance and desired performance. Once the need had been established, an analysis of the tasks performed by the job incumbents was conducted. The tasks were divided into two groups, those selected for training and those selected for implementation via job performance aid. The guidelines for the development of the JPA were established, and the learning theory relevant to the tasks selected for training was researched. A review of the literature applicable to this project is included. A summary of the budget and planning for the project are also included. The Interservice ISD model (Branson, et al., 1975) features five phases during the analysis:

1. Analysis of the Job Tasks.
2. Selecting Tasks for Training.
3. Constructing Job Performance Measures.
4. Analyzing Existing Course Material.
5. Selecting the Instructional Setting.

In this document, phases one, two, and five appear in this chapter under the heading Job Task Analysis, the fourth phase follows the statement of the instructional goal. The third phase appears in Chapter Three, Design.

Needs Analysis

The analysis phase is the most important of the five phases of ISD and the needs analysis is perhaps the most important part of the analysis. When developing training for a military customer, a thorough needs analysis is performed by the contracting organization; and the need is clearly identified before the government solicits bids for the training development contracts. In this case, it was up to the ISD staff at S/TP to analyze the needs of the electron beam lithography integration team, or to paraphrase Dick and Carey (1985), identify the difference between what was and what should have been. Determining exactly what the e-beam integration team required and setting instructional goals accordingly was the foundation of the project. If the original needs assessment was wrong, the entire project would have been misguided. Meetings were held with the management of the EBL group to clarify what they felt was required by their personnel. Interviews were conducted with the engineers to determine their exact requirements. The job task analysis was initiated which shed considerable light on what the needs of the engineers were. Finally, a meeting was held and the needs definition was reviewed and agreed on by all concerned parties. Twelve jobs were identified as necessary to successful integration of an EBL device. In the Interservice ISD procedures, the various jobs that are to be enabled are referred to as the terminal learning objectives. A list of the terminal

Table 1

Terminal Learning Objectives

1.0	Initial Conditions
2.0	Power Up the System
3.0	Beam Alignment Procedure
4.0	Beam Quality Adjustment (Astigmatism and Focus)
5.0	Beam Shape Adjustment (Shaping)
6.0	Servo Calibration (Double Deflection)
7.0	Turn Projection Lens Off/On
8.0	(Proprietary to IBM)
9.0	(Proprietary to IBM)
10.0	(Proprietary to IBM)
11.0	Electrostatic Calibration
12.0	Dynamic Corrections

learning objectives for this project appear in Table 1. It was agreed that mastery of these twelve tasks were essential, but the method for achieving mastery had yet to be determined.

Job Task Analysis

The first step after identifying the terminal learning objectives is finding out what is done by a person performing those jobs correctly. That is the object of the job task analysis. One engineer was assigned by e-beam systems management to be the liaison between the designers and the e-beam systems group. To minimize interference with the production schedule, the designers chose to videotape the e-beam system engineers as they performed their tasks. This allowed the designers and the liason to review the procedures as often as needed without having the engineers repeat the demonstration. Nearly all of the job tasks were identified by analysis of the tape. Specific questions were formulated and answered in a non-interfering manner. How much SME time was saved by the videotaping was never established, that was beyond the scope of the project. However, it was obvious to everyone concerned that it did save a substantial amount.

A second tool was developed by the ISD group to assist in the compilation of the task list. The nature of the tasks and the equipment needed for the performance of these tasks made it difficult to describe the tasks verbally. A production tool was needed to facilitate the analysis. Storyboards were created that featured a line drawing of each component panel with all switches, knobs, meters and displays. The storyboards, as shown in Appendix A, also provided areas for video production notes, authoring notes and general notes. They proved to be valuable many times during the course of the project.

Analysis of Job Tasks. Armed with a videotape of the job incumbants at work and the storyboards, the designers and the liason engineer proceeded to analyze the terminal learning objectives to determine the tasks performed in the course of these jobs. A list of enabling objectives for each terminal learning objective was made by reviewing the VHS work tape. Each enabling objective had to be further broken down into a step list (U.S. Army, 1975). The step list was given to job incumbents via the liason engineer, and the technical accuracy was confirmed or refined. A problem arose due to the nature of the EL-3+ development project. The system hardware and software were being integrated for the first time and were constantly being modified. Consequently, the steps involved in the operation were subject to change. It was absolutely critical to the success of the training program that the step list be exact and unambiguous. The designers assumed that the steps, as they existed at this time, would be close enough to continue the ISD process. The precise, final version of the steps would be determined in the development phase during the formative evaluation. Included in this document in Appendix B, is the step list for terminal learning objective 3.0, Beam Alignment Procedure. It is representative of the twelve step lists that were developed.

Selection of Tasks for Training. For many jobs, all of the tasks performed by a job incumbent do not need to be included in training. For example, a jet pilot needs to inspect the cockpit for foreign objects before flight. This is an important part of the job but it is not included in the training curriculum. Due to the nature of the job and the tasks performed by the e-beam systems engineer, none could be excluded. Each and every step performed by the e-beam engineers is critical and cannot be ommitted. Any of the jobs that they perform that were non-critical were eliminated during the needs assessment and the development of the terminal learning objectives.

Selection of Instructional Setting. On the surface, this doesn't seem to be an important item, and it has a tendency to be glossed over. However, this step involves more than just defining "where" the instruction will take place. "Often, instruction is thought of as being limited to a school setting. This is partly because of a strong tradition for conducting training in schools even when good alternatives are available" (U.S. Army, 1978). The Interservice ISD model suggests five possible instructional settings:

1. Job Performance Aid (JPA).
2. Self-Teaching Exportable Package (STEP).
3. Formal On-the-Job Training (FOJT).
4. Installation Support School (ISS).
5. Resident School (RS).

It was obvious to the developers that training would not be the most efficient way to enable mastery of many of the tasks. The solution was development of a job performance aid. A method and criteria had to be established for deciding which tasks were appropriate for training and which tasks could be performed with the guidance of a job aid. "There is no known way to proceduralize the formation of JPA/Training trade-off ground rules. Many factors need to be simultaneously considered in a rather imprecise way" (Joyce, et al., 1973). Several sources were turned to for developing the trade-off criteria. Anderson (1985) provides a checklist to help determine if job performance aids are appropriate. The Air Force Human Resources Lab's Handbook for Job Performance Aid Developers (Joyce, et al., 1973) lists many relevant criteria. The following guidelines were adopted by the designers:

Put in Training:

- a. Tasks which are performed frequently on the job.
- b. Tasks performed by a large proportion of the individuals in a given specialty.
- c. Tasks that are not easy to learn on the job.
- d. Tasks that are hard to communicate with words.
- e. Tasks that do not take an exorbitant amount of money to train.

Put in Job Performance Aids:

- a. Behavior sequences that are long and complex.
- b. Tasks that involve readings and tolerances.
- c. Tasks that are aided by the presence of illustrations.

d. Tasks that utilize reference information such as tables, graphs, flowcharts and schematic diagrams.
e. Tasks with branching step structure.
f. Tasks that are performed rarely.

The last criterion, not listed, is common sense. If a task seems appropriate for training, develop training. If it seems appropriate for a job aid, develop a job aid. If it seems appropriate for both, put it in both (Joyce, et al., 1973). The formative evaluation will reveal whether the instructional approach should or shouldn't be revised. It was decided to incorporate the step lists for all terminal learning objectives into the JPA. According to Joyce, Chenzoff, Mulligan, and Mallory (1973), if the knowledge of the user is overestimated, there is the likelihood that the JPA will not be useful. The designers felt that having all the steps in the JPA was not the most efficient way to enable mastery of the terminal learning objectives, but it did guarantee that performing them would be possible. The designers felt that the job performance aid could be used most efficiently by first teaching the user some fundamentals. An easy way to visualize this arrangement is to imagine the relationship between a cookbook and a cook. A cookbook is a job performance aid for a cook. Teaching a person the basics of cooking is an appropriate task for training. However, teaching hundreds of different recipes does not make sense. The cook will forget all but the most frequently used recipes. The cookbook eliminates the requirement of committing little used recipes to memory. Teaching the basics of cooking and how to use a cookbook makes for the most efficient use of the cookbook.

Although it was decided that all the steps would be included in the job aid, many of the learning objectives were appropriate for training. A formal school setting was out of the question. Formal on-the-job-training would require training the trainers. This idea was also ruled out. A self-teaching exportable package seemed to be the best way to implement any training that was going to be developed. The designers felt that the best way to enhance transfer of learning to the job aid and to the actual equipment was to use the training module in close proximity to that equipment. Like the job aid, the self-teaching exportable package requires no instructors, is self-paced, and is user controlled. If follow-on training is developed at a later date and a full curriculum is developed, it may be appropriate to switch the training setting to an Installation Support School environment. Until then, the current setting selection, self-teaching exportable package is adequate and preferable.

A sub-set of operation of the Alignment Brightness FRU (Field Replaceable Unit) was identified as fundamental to the operation of an EBL system. The keystrokes and observations required to align the electron-beam are performed perhaps dozens of times during the integration of an EBL system. Relying on the job aid to perform these steps would be a needlessly time consuming activity. Consequently, this aspect of the operation of the ABF was chosen for development into a training module.

Media Analysis. It was essential to the success of the program that a delivery medium be developed that would enable most efficient use of the information contained in the step lists. It was also essential that the delivery medium be chosen before a budget and schedule are made. The next step of the analysis phase was more decision-making, a media analysis, or selection of delivery medium. Several media selection models were reviewed but the U.S. Army model (1988) was the most up-to-date and considered many types of state-of-the-art technologies. There were three factors that influenced the selection of the delivery media: size of target population, need for repeatability and accuracy of instruction, and requirement for motion visuals.

1. The small size of the target population meant that it was not economical to maintain a permanant training staff for teaching these skills. Informal on-the-job training was the normal way to learn the tasks.

2. The instruction had to be completely accurate and repeatable, meaning that all learners receive the same instruction. When there is no permanant staff or formal training structure, accuracy and repeatability become very difficult to maintain. Informal on-the-job training is a subjective process that can be successful but is seldomly repeatable.

3. A critical aspect of the job aid was the requirement for motion visuals of the various waveforms the user must use for reference during the set-up procedures. The training module required high-quality visuals as well.

Interactive videodisc, computer-based training (IVD/CBT) was selected as the delivery medium. Videodisc is simply a storage medium much like a floppy disc. It stores video, similar to a videotape. The computer software controls the videodisc player. Unlike videotape which is a linear format (meant to be played from beginning to end), the videodisc player affords random access to any of the 54,000 frames of video stored on one side. Interactive simply means that the sequence of the presentation is determined by the user's responses. This medium allows for motion visuals and accurate, repeatable instruction. When modifications are made to an EBL system, the training and job aid software can be updated once. All subsequent instruction will be accurate. The training module can be implemented on the same computer hardware that the job aid uses to avoid the cost of duplication of the hardware. The IVD/CBT equipment is an ideal medium to use with self-teaching instruction for this project.

Target Population Analysis

The job performance aid and the training module were designed with two different target populations in mind. The JPA was designed to be used by experienced e-beam systems engineers at either Grumman or IBM. A person in this position must have, as a minimum, a B.S. degree in either physics or electrical engineering and one year hands-on experience with either the analog control systems or the beam column of an earlier EL-3 device. The training module was designed to be used by entry level e-beam systems engineers at IBM. A person in this position would have as a minimum an Associates degree in either physics, electrical technology, or engineering with no experience on an EBL system. If time and budget are authorized in the future, it is hoped that a complete training package be developed to give an entry level engineer the necessary knowledge and skills to use the job aid at maximum efficiency.

Organizational Constraints

Constraints imposed by the organizations and their impact on this project fall into two categories; those that effect the development and those that effect the implementation.

The implementation of the project was affected by the target customer. The media analysis model that was used to select the appropriate delivery media supported the selection of computer-based interactive videodisc. Grumman Simulation/Trainer Products has a great deal of experience developing instruction for this medium. The constraint was imposed by the fact that IBM, as the target customer, required the delivery system to use IBM hardware and software wherever an IBM part was available for the job. This required the developers to deliver instruction via the IBM InfoWindows Presentation System hardware and software. This fact turned out to have a significant impact on the project.

The development of the project was constrained by the delivery schedule of EBL number 27 to IBM. The SME's were to be pulled away from production work as little as possible. It was stated by the Director of E-Beam Systems that this project was to be minimally intrusive. The use of VHS videotaping during actual production integration work allowed the designers to work within the limits of this constraint. Similarly, the on-site video taping for production of the videodisc was to take up as little production time as possible. The courseware was designed to rely heavily on text and graphics and use actual video as little as possible. The cost of development for computer graphics is higher than that for video production, but the possible impact on the delivery schedule of number 27 out-weighed that. Consequently, the production videotaping was scheduled to be done on off-hours, or during down-time.

One other organizational constraint must be mentioned concerning this document. This document cannot contain any information that would be considered proprietary to either Grumman or IBM.

Instructional Goal

The training module and job performance aid will enable an engineer with no experience with electron beam lithography device number 27 to correctly perform the beam bring-up procedures, assuming the device is fully functional.

Literature, Existing Course, and Material Review

The uniqueness of the electron beam lithography process and the limited application of it makes finding information about it difficult. Most of the information available on e-beam lithography deals with the application of the technology (Pfeiffer, et al., 1988), and (Pfeiffer, 1984). Fortunately, for both the developers and the readers, it is not necessary to discuss the technology here. This project deals strictly with the correct operation of the device and not with the physics of why, or even how it works. The literature that was available and selected for use, dealt with the application of cognitive and behavioral psychology to state-of-the-art delivery technology.

Related Theory

The tasks to be learned in the course of the training are classified by the type of learning outcome as described by Gagne (1984). The two categories that apply for these tasks are Verbal Information and Intellectual Skills. The latter category can be broken down further to three sub-categories: defined concepts, rules, and problem solving. The distinction between these categories can be easily understood when they are ranked by Bloom's taxonomy of the cognitive domain (1956). Table 2 is a representation of that taxonomy.

Table 2

Taxonomy of the Cognitive Domain

1.	Knowledge	Recognition and recall of facts.
2.	Comprehension	Summarize or paraphrase facts.
3.	Application	Use of information in a situation different from original learning context.
4.	Analysis	Able to separate whole into parts and demonstrate knowledge of relationship between elements.
5.	Synthesis	Combine elements into new entity different from original one.
6.	Evaluation	Decision-making based on criteria and rationale.

The difference between intellectual skills and verbal information is a subtle but important one. Verbal information falls in the first category, knowledge. Knowledge is the learning of facts or simply "knowing-that..." For example, the learner may "know that" pressing the RESET pushbutton clears the ABF keypad display. When asked to demonstrate that knowledge, the learner could state, "pressing the RESET key will clear the ABF keypad display." Intellectual Skills include the next five levels of Blooms taxonomy and involve increasing degrees of understanding of verbal information, or knowledge. The distinction between "knowing-how" rather than "knowing-that." For example, to demonstrate intellectual skill at the application level, when presented with a simulated situation where the ABF keypad display needs to be cleared, the learner would have to select the RESET key. The lowest level of intellectual skill is comprehension. A defined concept falls under the category of comprehension. The learner may "know that" alignment means in-line, but "alignment" in the context of the e-beam system must be defined using other verbal information. Rules are one step higher yet in the taxonomy of the cognitive domain, at the application level. At this level the learner is starting to really use his head. As Gagne said, "Rules are the stuff of thinking" (1984). In a broad sense, rules can be thought of as procedural knowledge. The objectives that designers seek to enable are almost all procedural in nature. Beginning with the next level, analysis, are the higher order cognitive skills. As a general group, they are referred to as problem solving skills. Problem solving, for our purposes, can be defined as the application of previously learned rules to new situations, guided by stored verbal information for interpretation (Gagne, 1984). The ultimate goal of the training program is to move the learner that one step higher in the cognitive domain to the higher order thinking skills, enabling problem solving while on the job.

Literature Review

The literature reviewed for this project fell into two categories: (1) the guidelines for the application of modern learning theory to state-of-the-art media technology and (2) reports on the results of the application of computer-based job performance aids to the manufacturing and processing environment. Areas of concern that were investigated included user motivation, transfer of learning, job performance, and monetary impact.

1. Hannafin M.J., Rieber, L.P. (1989). Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies. Educational Technology Research and Development. Vol. 37, No. 2, 91-114.

The authors claim that most computer-based instruction relies too heavily on behavioral approaches and not enough on cognitive approaches to learning. A discussion follows that demonstrates applications of cognitive and behavioral psychology to computer-based delivery media. The authors also propose a development model that employs the best of both worlds.

2. Alessi, S., (1988). Fidelity in the Design of Instructional Simulation. Journal of Computer-Based Instruction. Vol. 15, No. 2, 40-47.

The author discusses how fidelity of simulation, or perceived realism affects rate of learning and transfer of that learning to the job environment (transfer of training). Contrary to popular belief, the author takes the position that rate of learning is affected by fidelity of simulation based on the relative skill level of the learner. He also proposed a taxonomy of simulation fidelity.

3. Reigeluth, C.M., Schwartz, E. (1989). An Instructional Theory for the Design of Computer-Based Simulations. Journal of Computer-Based Instruction Vol. 16, No. 1, 1-10.

The authors discuss the psychological and behavioral components of simulation design and their application to reduced-fidelity, computer-based simulation. The authors recommend several strategies based on the desired learning outcome.

4. Yuan-Liang, D.S. (1984). A Review of the Literature on Training Simulators: Transfer of Training and Simulator Fidelity. (Contract No.: N00014-82-K-0487) Arlington, Va.: Office of Naval Research.

The author reviews and summarizes the research that has been done into simulator design and the impact of various aspects of the designs on transfer of learning to the job environment. Of particular interest for this thesis/project was research regarding how different types of tasks to be learned required different levels of fidelity for efficient learning.

5. Gagne, R.M., Wager, W., Rojas, A. (1981). Planning and Authoring Computer-Assisted Instruction Lessons. In D.W. Walker & R.D. Hess (Eds.). Instructional Software (pp. 55-67). Belmont, Ca.: David S. Lake.

The authors described various applications of Gagne's nine events of learning to computer-assisted Instruction. Examples are given for verbal information, defined concepts, rules and problem solving. Although the article was somewhat dated, the examples given were easily applied to modern technology.

6. Lane, L. (1989). Interactive Videodisc: A Success Story. Instruction Delivery Systems. Sept./Oct. 1989, Vol. 3, No. 5, 12.

The author researched the use of the IBM InfoWindow Presentation System for training at Goodyear Tire and Rubber Company. The training taught maintenance procedures for the Allen Bradley PLC 2/20 Programmable Controller. She found that the workers enjoyed the IVD/CBT format and that the performance of all workers regardless of skill level increased. Most importantly, the machine up-time increased by several hours a week. This article highlighted the use of identical development and delivery media for a very similar application. This was used to support claims by the designers that the underlying concept of this project was sound.

Survey of Existing Course and Materials

Existing course material for e-Beam systems training is nonexistant. Until this project, there has been no formal training for any of the engineering staff. Training for Grumman personnel has been done strictly in an informal on-the-job training fashion. There is no formal documentation on the system as a whole. Individual components in the system are well documented in straight engineering fashion. One document (IBM, 1987) was available on the operation of the Alignment Brightness FRU. To further compound the problem, each of the e-Beam devices built thus far has been unique to some degree and number twenty-seven is unique as well. What documentation there is consists of engineering notebooks and some general procedures lists.

Plan for Design and Development Effort

Any project regardless of its scope or intended outcome must follow a plan to achieve the desired results in the desired time-frame. The type of project and the nature of the desired results must be considered when creating the project plan. There are two types of IVD/CBT projects according to Larson (1989), productivity-oriented and experimentally-oriented. In a productivity-oriented project, the emphasis is on efficiency, getting the job done on-time and within budget. In experimentally-oriented projects, the emphasis is on creativity, developing new products and developing new processes. In the case of this particular project, the product was similar to other IVD/CBT projects done in the past, but the process being employed for development was totally new. The IBM InfoWindow Presentation System (IWPS) was specified as the delivery medium as well as the development environment. Although the developers had experience with a variety of authoring systems and languages, the IWPS was a new and unique combination of hardware and authoring system. The plan for this project had to include time to come up-to-speed with the new authoring environment. This manifests itself in two different ways; as a user, learning how to operate the system in an efficient way, and as an instructional developer, learning what the capabilities of the system are and how they can be used to develop various instructional strategies. During the development phase, this became a serious issue that is addressed in that chapter.

Project Plan

A plan was made by the instructional development team that would allow for delivery of the job aid/training system within a budget agreed to by Grumman and IBM. A schedule was adopted that the E-Beam Systems management felt would maximize the usefulness and marketability of the training/job aid system. The author was responsible for creating the schedule and assessing the manpower requirements to complete that schedule. The schedule that was made allocated time for the five phases of the ISD model. Additionally, time was included during the development phase for producing the courseware and the videodisc. As the project progressed, the schedule was revised to reflect changes in the development process. Pert charts were not required by Grumman management, however, the project flow diagram in Figure 1 is essentially a Pert chart. Appendix C contains copies of the actual Gantt charts that were included at the program review meetings.

Estimated Student Effort

The effort necessary to use the materials developed in this project is divided into two categories, the training module and the job aid. The training module should not take more than a half-hour to complete. The purpose of the training module is to enable more efficient use of the job aid by eliminating the need to use the most detailed level. If a user had to follow the most detailed level of the job aid from start to finish, assuming that it is possible, the designers estimate it would take as much as twelve hours to complete. The designers did not intend for the job aid to be used in that fashion however. Any single user may use it for between one-fourth to eight hours.

Budget

The budget for this project was based on the typical costs of engineering development for the Grumman Corporation. The designers did not have access to the contractual information regarding IBM's financial involvement. The cost was calculated using a labor rate of $75.00 per man-hour. This price includes pay, benefits and administrative overhead. Approximately 300 hours of the authors personal time (not compensated by Grumman) was spent on this project. Since the author's time does not include the administrative overhead that the Grumman compensated time includes, an adjusted hourly rate of $25.00 per hour was used. The budget included the cost of engineering support, engineering supervision and a graphic artist in addition to the two full-time ISD engineers. A breakdown of the development costs appears in Table 3. A more detailed breakdown of the hardware and software costs, as well as a weekly breakdown of the estimated versus actual man-power costs appear in Appendix D.

Summary

An analysis was conducted by Grumman Simulation/Trainer Products of the needs of the Grumman Electron Beam Lithography group. The jobs and the job tasks of the e-beam systems engineers were analyzed and a recommendation was made to develop a job aid and training program. The tasks were divided into the

Table 3

Development Cost Breakdown

Description		Cost	Sub-total	Total
Materials				
Hardware		$ 9.5		
Software		5.5		
Miscellaneous Expendables		2.0		
Videodisc Mastering (3M)		3.5		
Total Materials			$ 20.5	
Labor				
Analysis	450 hrs.	$ 33.75		
Design	450 hrs.	33.75		
Development	600 hrs.	45.0		
Graphic Artist	80 hrs.	6.0		
Engineering Support	80 hrs.	6.0		
Implementation	150 hrs.	11.25		
Evaluation (Control)	150 hrs.	11.25		
Management	180 hrs.	13.5		
Documentation	300 hrs.	7.5		
Total Labor	2440 hrs.		$ 168.0	
			Total Cost	$ 188.5

All dollar figures are multiples of one thousand.

tasks for a job aid and tasks for training. Guidelines were adopted for the development of the job aid. Learning theory was researched for developing the training. A plan was developed to guide the overall project and a budget was made.

CHAPTER 3

DESIGN

Introduction

The analysis work done in the first phase of the project provided the designers with a solid foundation on which to build a program. Now the designers had to change hats, so to speak. They had to make a transition from analyzing the job of the e-beam systems engineers to designing a program that would address the specific needs that had been identified. During the design phase the developers created the framework of the program that was to be fleshed out in the development phase. The framework began with a blueprint, the instructional task analysis and creation of the instructional objectives. The blueprint continues with the grouping and sequencing of the objectives. The framework begins with the establishment of guidelines for the job aid. In a parallel effort, a design for the training module based on research into the learning theory discussed in Chapter Two began. The instructional activities were specified, computer-based tutorials and simulation. Finally, a plan for evaluating the design during the development phase was made, as was a plan for evaluating the overall impact of the project after the implementation.

Instructional Task Analysis

The job task analysis done in the first phase led to the identification of several learning objectives appropriate for training. Terminal learning objective 3.0, Beam Alignment

Procedure was examined for procedures that should be implemented via training. This is the first procedure that is performed and is subsequently performed many other times during the set-up of an EBL system. Teaching an entry level user all the steps of beam alignment procedure would have been a pointless endeavor. The instructional task analysis narrowed the scope of the training down to a more practical level. The results of the instructional task analysis are given in Table 4.

Table 4

Instructional Tasks
Beam Alignment Procedure

Enabling Objective	Description
3.1	Align 1st Aperture
3.1.2.1 - 3.1.2.5	How to use the ABF Keypad
3.1.2	Set 2nd Alignment to One Side
3.2.2	Minimize 2nd Aperture DVM Reading
N/A	Definition of Alignment

The designers chose enabling objective 3.1, Align 1st Aperture for full development into a training module. This objective is basically two procedures in one; set the 2nd alignment to one side, and then minimize the DVM current reading by adjusting the 1st Aperture. Because those two steps are used in many other alignment procedures, the designers felt that teaching this procedure would make using the job aid much easier. The keystrokes necessary to initiate an alignment procedure also had to be included. In addition, the analysis of the job tasks led to a decision to teach the learner something about what happens electronically inside the beam column when adjustments are being made. During interviews with the SMEs, the developers learned that it is especially helpful to the operator to understand what is physically occuring as the device is "tweaked." The designers felt that if the learner was given some knowledge of the inner workings of the device together with some rules about how to operate the device, some higher order cognitive skills, such as analysis (Bloom, 1956) could be attained. Achieving higher order skills would lead to "far" transfer of learning (Reigeluth and Schwartz, 1989) and consequently better user performance. For further discussion on transfer of learning, see the section of this chapter titled; Transfer of Learning Specification.

Instructional Objectives

The procedures involved in setting-up the EL-3+ system for operational use are complex and many. These procedures must be performed correctly. Consequently, it is imperative that the learner is taught the correct procedures. Learning the correct procedures is a two tiered process. First, the procedures being taught must accurately reflect the actual procedures. That issue was addressed in the analysis phase. Secondly, specific criteria must be established to determine if the learner has mastered the objectives. When developing training, job performance measures are the criteria used to design training and to evaluate the post-training behavior of the learner. A similar type of methodology is required when developing job aids to enable the desired performance from the user. Level of detail guidelines become the standards for the job performance aid. This segment of the design phase corresponds to Phase III of the analysis in the interservice ISD model, constructing job performance measures.

Job Performance Measures

The development of instructional objectives, or job performance measures are a critical step in the design phase. "The job performance measure becomes the standard against which, the trainee's performance will be ultimately judged" (Brandon, et al., 1976). Each task that was identified for training is described in terms of observable performance, conditions under which the performance takes place and standards by which the quality of the performance is judged (Mager, 1984). In other words, this is what the designer expects to see a learner who has completed the training do. In order to be sure that the desired behavior is described properly, care must be taken when creating job performance measures. Each task must be categorized by domain of learning outcome (Gagne, 1985). For a discussion of these categories see Chapter Two. The example is from the cognitive domain at the application level. Bloom (1956) suggests verbs appropriate for describing behavior based on the level of skill involved. All job performance measures were created using Bloom's guidelines. An example job performance measure is given in Table 5. The step list that appears in Appendix B, specifies the conditions, the behavior, and the standards for the entire beam alignment procedure. From the job performance measures, the subskills and prerequisite knowledge are defined. Any prerequisite knowledge necessary to use the job aid is included

Table 5

Sample Job Performance Measure

Task:	Set 2nd Alignment to One Side.
Performance:	Monitor the 2nd Aperture Current and use the ABF keypad to misalign the beam in the +X direction.
Conditions:	As described in terminal learning objectives 1.0 Initial Conditions, and 2.0, Power-up Procedure.
Behavior:	1. Selects "2A" position on the Monitor Select Switch and the "TGT/RST" position on the S/A/T Switch. 2. Selects and presses the following keys in the given sequence: "RESET", "5", "ENTER", "2". 3. Selects and presses the Right Arrow key until the current reading is maximized.
Standards:	+ or - 0.001 uA from maximum on the DVM.

as part of the job aid. However, to enable higher order problem-solving skills in a user, prerequisite knowledge not given in the step list is essential. For the example in Table 5, the learner must understand a three-dimensional coordinate system. This is a good candidate for an entry skills pretest. The learner should also be able to explain what is meant by the term "align" in this context. That definition should be taught in a earlier segment of the lesson.

Level of Detail Guidelines

Like the job performance measures, the level of detail guidelines address the type of task being performed in terms of the domain of the learning outcome. For each category, descriminations and perceptions, problem solving and decision making, and motor skills, guidelines for implementation of the job performance aid were established by the designers.

Descriminations and Perceptions.

A. Reading Quantitative Values. All DVM readings are to be indicated with the JPA. The tolerances will be specified where appropriate.

B. Observing Gross Indications. A verbal description of when a lamp illuminates is sufficient. A graphic depiction of the illuminated lamp may be used as well.

C. Reading and Interpreting Oscilloscope Patterns and Waveforms. The correct waveform for every scope measurement will be displayed by the JPA. Sample incorrect waveforms will be provided. Wherever possible, a motion visual of the waveform while the corrective adjustment is being made will be shown. Switch settings will be available to the user at all times.

Problem Solving and Decision Making

A. Selection of Appropriate Next Step or Task. For every step in the complete Step List, the next step will be specified.

B. Exercising Judgement. At every decision point, all the possible paths will be described and a recommendation will be made based on the previous actions of the user. Samples of incorrect waveforms will be provided where appropriate, along with a description of possible causes.

Motor Actions

A. Activating Switches. Every switch that is activated will be shown in the new position. A text description will be given as well.

B. Adjusting Continuous or Multipurpose Controls. The location of the indicator that displays the result of the adjustment will be shown as will the expected reading.

Establishment of Required Entry Behaviors

Although the knowledge of the entry level user will be great, by virtue of their educational background, the minimum qualifications for use of the training program and job aid are significantly less. The user of both the job aid and the training module should be able to demonstrate knowledge of basic physics. The user of the job aid must have working knowledge of a dual trace oscilloscope and a digital ammeter. The fact that a user of this system was hired for an e-beam systems engineer position implies that these prerequisites were met. In a more robust training program, these skills would be tested, and remediation would be provided for those without them. For demonstration purposes only, the user of the training module will encounter an embedded quiz that requires knowledge of a three-dimensional coordinate system.

Grouping and Sequence of Objectives

Up to this point in the project, the designers were primarily concerned with "what" was going to be presented to the learner. With the grouping and sequence of objectives, the thrust shifts to "how" the information will be presented. The tasks to be taught on the ABF were analyzed to decide how they could be explained with greatest efficiency. For the job aid, this aspect is simple. The steps are presented in the order that they must be performed. For teaching the user about the operation of the system, the approach is not so clear cut. The designers had to decide which steps constitute prerequisite knowledge for other steps. For instance, learning activity 2.0, How to Use the ABF Keypad, teaches a sequence of keystrokes that are used in each of the following activities. It was obviously appropriate to teach those steps first. Similarly, the steps for Learning Activity 3.0, Set 2nd Alignment to One Side are a subset of the steps for Learning Activities 4.0 and 5.0. The final grouping and sequence of the objectives appears in Table 6.

Table 6

Grouping and Sequence of Objectives

Learning Activity	Enabling Objective	Description
1.0	N/A	Definition of Alignment.
2.0	3.1.2.1 - 3.1.2.4	How to use the ABF keypad.
	3.2.2.1 - 3.2.2.2	"
	3.3.2.1 - 3.3.2.2	"
	3.4.2.1 - 3.4.2.2	"
3.0	3.1.2	Set 2nd Alignment to One Side.
4.0	3.2.2	Minimize 2nd Aperture DVM Reading
5.0	3.1	Align 1st Aperture

Learning Activities Specification

It had been decided in the analysis phase that the best method for insuring that the e-beam system technical staff achieve mastery of their job tasks was with a job aid. What the designers were concerned with at this point was developing the job aid and a training program that would complement each other. The purpose of the training module would be to increase the efficiency of the job aid. The setting for the delivery of the information had been specified and the media chosen as well. The task before the designers now was to begin with the broadest design requirements and systematically narrow-down the specifications until the lessons were completely designed.

Instructional Strategy

Within the scope of IVD/CBT, many instructional techniques are possible. Alessi and Trollip (1985) list five possible ways to teach with computers: tutorials, drills, simulation, games and tests. Additionally, the job performance aid was available as a learning method. Each of the methods above were evaluated as a means to enable the terminal learning objectives. The results are found in Table 7, the instructional strategy matrix.

Table 7

Instructional Strategy Matrix

Learning Activity	Instructional Technique	Media Implementation
1.0	Tutorial	Text/Graphics/Video
2.0	Tutorial	Text/Graphics/Video
3.0	Simulation	Text/Graphics/Video
4.0	Simulation	Text/Graphics/Video
5.0	Job Performance Aid	Actual Equipment

Conventional computer-based tutorial was selected for the first two tasks. Both tasks are in the domain of cognitive skills, what Gagne (1984) calls verbal knowledge. Tasks three, four and five are higher order cognitive skills known as rules. Computer-based simulation was chosen as the instructional method for learning activities three and four. "Simulations typically have three major advantages over coventional tutorials, drills and tests. The first is that they enhance motivation; the second is that they have better transfer of learning; and the third is that they are more efficient" (Alessi and Trollip, 1985). Simulation has also been shown to enhance retention. A study conducted at Digital Equipment Corporation of in-house, interactive videodisc training programs demonstrated that the average learner retained

43 percent of what they hear and see, but retain 70 percent of what they hear, see and do! (Mann, 1989). The choice of using the job performance aid for learning activity five was made for one reason; it makes a natural transition from the simulation to the actual equipment which should enhance transfer of learning. Thus far, the learning activities had been defined in only a very general way. As the more general aspects were refined, the actual lessons began to take shape. At this point, the designers had chosen tutorial, simulation and job performance aids as the instructional strategies. Guidelines for the development of the job aid had been made. Now, learning activities had to be designed for the tutorial and the simulation. The designers had to work within certain guidelines while designing the learning activities. The most important guideline was the job performance measures. Designing the training so it would increase the efficiency of the job aid was the second. But other guidelines were necessary for the development of the simulation. The designers had to examine the level of realism needed for the simulation.

Fidelity Analysis

The first step in the design of a simulation is the fidelity analysis. This serves a similar purpose as the level of detail analysis that was done for the job aid. Fidelity, as defined by Yuan-Liang (1984) is "the degree to which a device or facility accurately simulates a machine or a system." A fidelity analysis is done to determine how realistic a simulation needs to be in the context of the specific learning objectives. The level of fidelity, or degree of realism, will affect the rate of learning as well as the transfer of learning to the real equipment. A fidelity analysis considers the domain of the instructional tasks and the terminal objectives. The type of tasks to be learned in this training module are a sub-set of the cognitive domain known as "rules" (Gagne, 1985). To teach rules via simulation, the designer had to develop what is categorized by Alessi and Trollip (1985) as procedural simulation. In this particular case, a physical simulation of the Alignment Brightness FRU (ABF) is to be done to allow learning its operational procedures. How realistic does the simulated ABF need to be? Johnson, in Yuan-Liang (1984), was able to show that high fidelity was not required for learning procedural tasks. The simulated reduced-fidelity environment is ideal for an entry level learner. The actual equipment can be quite intimidating and is significantly less conducive to learning. This intimidation factor caused by actual equipment or high fidelity simulation is called overload. Reigeluth and Schwartz (1989) define overload as, "The degree to which details or complexities of the real situation provide too many new stimuli for the learner to be able to acquire the desired content." In summarizing his research into simulator fidelity reqirements, Alessi (1988) gave two reasons why reduced fidelity improved learning for a novice.

1. High fidelity means higher complexity which taxes memory and other cognitive abilities.
2. Proven instructional techniques which improve initial learning tend to reduce fidelity.

Imagine the case of trying to teach a novice pilot to fly a modern jet airplane. In an actual cockpit of a real airplane, the learner could easily be overwhelmed by the complexity. By introducing the learner gradually, through classroom instruction, reading, videotapes, reduced-fidelity simulation and then a training aircraft, the learner will advance at maximum efficiency. A novice will learn best on low-fidelity media while an expert will learn best on high-fidelity media or actual equipment (Alessi, 1988).

The designers wished to make the simulated ABF keypad many times larger than actual size to prevent touch screen errors. Similarly, the designers wished to move the location of the ABF displays to conform to the dimensions of a video display terminal. The research that was reviewed supported these decisions. The actual ABF keypad is black with white lettering. The color was deemed unimportant as well, and the simulated keypad was made gray with white lettering for both technical and esthetic reasons. After development, it was noticed that the reaction speed of the simulator was considerably slower than the actual equipment. This could present a problem to an expert during a simulation, but as long as the target population consisted of novices, the slow reaction time was not considered significant. For a procedural simulation, the single most important feature of fidelity is the actual reaction. The simulation must respond the same way that the actual equipment responds, that is, the displays must accurately reflect what the user has done with the keypad. This issue is discussed in depth in the section on feedback.

Learning Activities Design

The next step was to apply modern learning theory with the computer-based media. It is safe to assume that IVD/CBT is not intrinsically superior to other instructional media, therefore, effective instruction will only exist if it is developed in accordance with acceptable learning theory. Hannafin and Rieber (1989) pointed out that despite the increased emphasis on cognitive learning theory in conventional instruction, most computer-based instruction is based on behavioral theory. The designers sought to strike a balance between cognitive and behavioral psychology in the development of this training module. A mix of both behavioral and cognitive theory was appropriate, but in what ratios, for which objectives? By starting with a broad overview of simulation development and gradually narrowing the focus, the designers hoped to encompass the most desirable attributes of both worlds.

Reigeluth and Schwartz (1989) identify three phases to learning via simulation: acquisition, application and assessment. Each of these general phases will be expanded later, but for now they are useful as a starting point for the discussion. In the course of the acquisition stage, the learner develops meaningful understanding of the subject, in this case, the steps in a procedure. Reigeluth and Schwartz (1989) describe two ways to acquire knowledge via simulation, expository and discovery. With the discovery method the emphasis is on participation. The learner is given prototypical examples or repeats a demonstration until the generality is discovered. If the user of the job aid were to repeat certain steps many times, the generalities would eventually be figured out and then the user would no longer need the job aid for that aspect of operation of the system. However, this is not an efficient way to go about learning. In the expository method the emphasis is on observation. The learner is told the generality and is then given a prototypical example. The expository portion of the simulation could take the form of a tutorial. The development of the expository tutorial forced the designers to look beyond the three stages of learning possible with simulation. The acquisition and application phases were broken down further into nine events of learning as described by Gagne (1985). Each event is characterized by an internal process that the learner experiences. To insure that these internal events occur, there are nine corresponding external steps that should take place for every objective during the course of the instructional activities. Table 8 provides an outline of these steps. The first three events are pre-instructional activities that serve to create the proper conditions for learning to occur. The fourth event through eighth event are when the actual acquisition of knowledge occurs. The ninth event is when application of the new knowledge takes place. For each objective in the training module, the designers considered the nine events of learning and applied them as guidelines for the cognitive aspects. Many aspects of behavioral psychology were employed as well. The various design considerations based on the nine events on learning are described below.

Table 8

Internal Processes and Their Corresponding Instructional Event

Internal Process	External Instructional Event
1. Reception	Gaining Attention
2. Expectancy	Informing Learners of the Objective
3. Retrieval to Working Memory	Stimulating Recall of Prior Knowledge
4. Selective Perception	Presenting the Stimulus
5. Semantic Encoding	Providing Learning Guidance
6. Responding	Eliciting Performance
7. Reinforcement	Providing Feedback
8. Retrieval and Reinforcement	Assessing Performance
9. Retrieval and Generalization	Enhancing Retention and Transfer of Learning

Pre-Instructional Activities

In behavioral studies, research has proven that in order for a desired behavior to occur, the proper conditions must exist. The same principle applies in cognitive learning theory, the proper conditions for learning must exist. The first three steps involve preparing the learner for learning.

1. **Gain Attention**. The first and arguably the most important step is to focus the learner's attention on the job of learning. Gagne, Wager, and Rojas (1981) suggest blinking text or audio tones to call attention to the computer screen. The use of videodisc and modern computer graphics allows for much more

sophisticated ways to gain the learner's attention. In this case, the training module begins with a colorful, eye-catching animation sequence of a hypothetical trip through the beam column. The sequence ends on a graphic representation of a properly aligned beam. Behaviorally, the use of touch-driven responses to stimuli provides for hands-on involvement that helps to maintain the learners attention.

2. **Inform Learner of the Objective.** An objective page is at the beginning of each lesson segment. It describes what the learner is about to encounter and describes what his or her performance will be upon completion. This helps to focus the learner's attention while initiating the internal process of expectancy.

3. **Stimulate Recall of Prior Knowledge.** In order for the learner to encode new information as it is presented, it is vital that the learner evaluate the new material in the context of previous knowledge. The prior knowledge must be recalled from long-term memory into working memory (Gagne, 1985). Embedded questions are a simple way to get the learner to recall concepts learned previously. The designers wished to include an embedded quiz as part of the training demonstration. It is to appear at the end of learning activity 2.0, before the learner begins learning activity 3.0. An embedded quiz provides at least two questions about a three-dimensional coordinate system.
These questions serve two functions. They test the learner for mastery of the prerequisite entry skills necessary for the lesson, as well as stimulate recall of prior learning.

Acquisition

The acquisition by the learner of new knowledge is the primary function of any training program. The steps the designers took to insure that the acquisition takes place are described below.

4. **Present the Stimulus**. A brief tutorial is presented in lessons one and two, and simulation is used in lessons three and four. Lessons one and two are the expository segments for the simulation in lessons three and four. The learner is told the generalities that apply to the operation of the Alignment Brightness FRU. Instead of being shown an example of the generality, the learner is given the option to use prompts in lessons three and four, in an adaptation of the discovery method, to perform the example. Graphics were to be used in lessons one, three and four to help the learner visualize the physical results of the procedure being described.

5. **Provide Learning Guidance**. One of the most beneficial things that an instructional developer can do for a learner is to supply the learner with a suggested means of encoding new information. Encoding has been found to have a tremendous influence on the ability to recall information from long-term memory (Gagne, 1985). A well known example of an encoding suggestion is using the name Roy G. Biv to remember the colors of the spectrum. To facilitate encoding, Reigeluth and Schwartz (1989) recommend a distinctive diagram with an accompanying definition as an alternative presentation to increase "depth of processing." Developing such an aid for learning the procedures

was not that simple. The designers had to identify an area that could benefit from an encoding suggestion, and then develop the encoding aid. During interviews with the job incumbents, the designers were told many times that one of the most difficult aspects of learning their jobs was visualizing what was physically happening inside the beam column while they manipulated the controls. The designers decided that a high quality visual representation of what the electron beam was doing as they performed the procedure would help the learners encode, and therefore remember the steps.

6. **Elicit Performance**. The internal process of responding, thinking about a stimulus and formulating a response, is a critical part of the learning process. A simulation of the Alignment Brightness FRU keypad and display was chosen to be used to elicit performance in lesson three. The learner has now been told the generality and must practice the example procedure. The learner has the option to rely on guidance from the system at this point. A series of prompts takes the learner step by step through an example, objective 3.0, "Set the 2nd Alignment to One Side." This task was chosen as an example because it is a subset of the next objective, "Align the 2nd Aperture." An on-screen prompt asks the learner, "What key will return you to the CMD [command] level?" If the learner remembers the generality from the previous lesson, the RESET key will be pressed. If the learner cannot recall, the HELP box must be pressed. A more detailed description of how help and prompts are implemented is given in the section on feedback.

7. Provide Feedback. Eliciting performance from the learner is only half the battle, it is essential to provide feedback to the learner to make the learner aware of the quality of his or her performance. Behavioral theory suggests that for maximum learning efficiency, feedback be immediate when learning procedural tasks. In addition to the timing, the type of feedback given is a critical factor in teaching procedures. Alessi and Trollip (1985) divide feedback into two categories; natural and artificial. Natural feedback is the normal expected consequences of operating the device. This could mean noises, lamps illuminating, displays changing or even motion! For example, when the RESET key on the ABF keypad is pressed, the ABF display will always display "CMD." That is the natural reaction of the system and is considered natural feedback when implemented in the simulation. "Natural feedback is usually sufficient for simple tasks but does not provide enough information for complex tasks that require a chain of responses before the natural consequences manifest themselves" (Reigeluth and Schwartz, 1989). The designers realized that artificial feedback was a necessity. Generally, artificial feedback is any feedback that is not a natural reaction of the system. Artificial feedback falls into two categories, informational and motivational. An example of informational feedback would be a prompt saying, "You need to use the left and right arrow keys." This is information supplied by the training device that the actual device would not supply. This type of prompting is sometimes called pre-response help (Reigeluth and Schwartz, 1989). Motivational feedback is a feature borrowed from the behavioral school known as reinforcement, usually taking the form of encouragement. An example of motivational feedback would be an overlay saying "Excellent, you breezed right through that!" Help is yet another type of feedback. If the designers feel that a particular step of the instruction is difficult, or the user may require assistance, help is usually offered to the user. Help may be offered by displaying an icon for the learner to touch to ask for assistance, or it may be displayed automatically after a predetermined elapsed time with no response.

8. **Assess Performance**. At some point in the training, the learner will feel confident that mastery of the skills has been attained. It is at this point that the learner should be able to demonstrate comprehension of the generality and mastery of the procedure. In lesson three, the assessment is done with the simulation. All help and feedback is removed and the learner must perform the procedure. The computer can easily keep track of the learners touches. The results will pinpoint the specific areas of weakness, if any, and branch the learner to a remedial sequence that will address the specific weakness.

Application.

Once mastery has been demonstrated for an objective, it is important to apply the newly acquired skill in the context of previous knowledge. Similarly, the learner must be able to apply the new skill in a variety of new situations.

9. **Enhance Retention and Transfer of Learning**. Finally, the simulation is used to introduce learning activity 5.0, "Align

the 1st Aperture." For this procedure the learner must recall to working memory all of the tasks learned thus far in the module and be able to apply them to the situation. Once again the learner will rely on the prompts and help. The systematic process of mastering a sub-task, and gradually building sub-tasks up to mastery of a larger task is a behavioral approach known as chaining. This method will enhance retention and should improve transfer of learning. In general, it should instill in the learner a sense of confidence that the new knowledge can be applied to any procedure they might perform on the system.

Scripting

Just as a movie or a play has a script to describe the sequence and substance of each scene, so does an interactive computer-based presentation. Storyboards were developed that described the various screens that the user sees. Flowcharts were also created to accompany the storyboards. The flowcharts describe the branching or sequence of the screens that are shown. Examples of the storyboards and flowcharts can be found in Appendices E and F respectively. Before presentation design of any kind could be made, decisions had to be made regarding the capabilities of the delivery media and how they could best be used. The most important decision, that required some careful consideration, was whether or not to use the audio capabilities of the system.

Audio Cost-Benefits Trade-Off

Before storyboards could be created, a decision had to be made concerning the use of audio and/or narration within the instruction. There is much research that supports the use of text enhanced by narration. The developers of this project wanted to include narration in the delivery of the material, but there was an obstacle on that path and a compromise had to be made. The compromise involved a trade off between technical capability, cost, and educational effectiveness. One side of a video disc can store 54,000 individual video pictures known as still frames. Each still frame is 1/30 of a second of video if the disc is played in real time. A video disc can store thirty minutes of real-time video, also called motion video. Like motion video, audio on the videodisc must be played in real time. That imposes two problems. First, there is a limit of one hour of audio, thirty minutes on each of two audio channels. Second, and more important, there would be a conflict with the still frame video. If the videodisc is "parked" on a still frame to show the user something, it cannot simultaneously play real-time audio. There are several methods for digital encoding of audio for videodisc, known as still frame audio. All of the still frame audio methods require additional hardware, special software, additional production time and added expense. It was decided by the developers that the effort and expense involved with incorporating audio out-weighed the additional benefits that it would provide. Consequently, other than a few prompts from the speech synthesis module in the InfoWindow Display, and various tone and beeps for touch acknowledgements, no audio is included in training or the job aid.

Storyboards.

The storyboards are the script for all aspects of the presentation that the learner will see during the use of the job aid and the training module. The following parameters are defined by the storyboards:

- All text messages that will either be on the videodisc or be part of the courseware.
- All video images that will be stored on the videodisc, both videotaped and computer-generated.
- All the computer-generated graphics that will be part of the courseware.
- Location on the screen where the various visual components will appear.

The storyboard sheets that were created to help describe the job tasks during the analysis phase were employed at this time to describe the presentation of the job tasks. The designers considered the research done previously in this phase to guide the creation of the presentation. The storyboards created for learning activity 3.0 appear in Appendix E.

Flowcharts

Flowcharts are a map for the lesson and job aid branching. The storyboards together with the flowcharts become the script for the lesson programmer. It also becomes the criteria for branching evaluation. The flowcharts describe the various paths from each decision point. The flowcharts and storyboards together, also describe whether the user or the software makes the branching decision. The flowcharts created for learning activity 3.0 appear in Appendix F.

Assessment System Specification

Ordinarily, an assessment method would be planned to measure learning when the training is implemented. This project does not call for any testing during implementation. An embedded quiz was included to facilitate learning. It could easily have been used to establish whether the learner had the prerequisite knowledge for the training module. However, the designers felt that the circumstances of this project made assessment of performance inappropriate. Instead, the evaluation system was designed to insure that a learning assessment was not necessary.

Evaluation System Specification

A project of this magnitude requires a plan to evaluate the quality and results of the implementation. From the outset, the designers faced a difficult quality control problem based on the dynamic nature of the procedures being enabled. The Interservice ISD model calls for evaluation (control) to be an ongoing process throughout the development of the training, continuing after the training has been implemented. The developers of this project adopted that approach. A trial module would be fully implemented to gain feedback as early as possible in the development phase. A traditional evaluation process was specified for the project as well. This was planned to occur in two phases. The first phase would be a formative evaluation of the training and job aid materials. This would take place as part of the development phase, before implementation. The second phase of evaluation was planned to be a summative evaluation, occurring after the final version of the materials had been implemented.

Formative

A formative evaluation traditionally would be done with members of the target population. One-on-one, small group and field trials would normally be conducted. The formative evaluation plan for this project called for one-on-one evaluations and field trials using Grumman personnel with similar skills as the IBM target audience. Under normal circumstances, that would be expanded to small groups of five to seven and finally field trials with groups of as many as thirty would take place. The job aid and the training were designed for one-at-a-time use, possibly two. Due to the limited number of personnel in the sample population, small group trials were not planned.

One-On-One Trials. At the early stages of evaluation, the designers need to work closely with the user. Gross errors are expected and many times, can be fixed on the spot. The plan for the one-on-one trials were to identify the most obvious errors and obtain reactions from the users to help refine the system.

Field Trials. The designers planned for field trials to take place when the training and job aid system was in a highly refined state. That meant that all of the problems encountered in the one-on-one trials were remedied. The purpose of the field trial was to determine if the system would in fact, enable the terminal learning objectives. For each terminal learning objective, the designers would decide which component learning objectives were critical to successful execution of the procedure. A plan was made whereby each of the critical learning objectives would be evaluated individually on a pass/fail basis.

The designers adopted five evaluation levels suggested by Meyers (1989) to describe the relative severity of the problems encountered.

Critical: Teaches erroneous content. For example, the user is told to adjust "A" but needs to adjust "B." This is a critical error because the user may damage the system or worse.

Serious: Fails to teach required content. For example, the user is told to do "A, then C" but should do "A and B then C." In this case a step is missing. This will not cause the user to damage the equipment but it will prevent the user from completing the task. Another example of a serious error is if the user is told to adjust "A" but no parameters are specified for the adjustment of "A." An experienced user may be able to get through this type of error, but those in the target population will most likely not.

Confusing: Content not organized or clearly explained. For example; too many touches between steps, terminology problems, wrong location given. The user will get through these problems but they must be fixed.

Minor: Typographic, spelling, etc.

Suggestion: These might be recommendations for simpler procedures that might save steps or provide insight to the user. These suggestions might be for changes in the presentation as well.

The evaluation plan called for the designers to observe a user performing the enabling objective under test. If the user encountered either a critical or a serious error, the job aid for that objective would fail. If the enabling objective could be successfully performed, it would pass. A similar evaluation method was planned for the training module. If it could be successfully used several times by members of the sample population, it could be considered sufficiently accurate for its purpose. Each enabling objective was to be evaluated a minimum of five times. The designers felt that this would allow for differences among the target group. If an enabling objective received five passes, it was certainly ready for implementation. If a procedure received a mix of passes and fails, the problems would probably be from the third category above. Additional study would have to be given to those procedures. The job aid directions might need to be reworded or the entry skills redefined. The designers had created forms with which to report the results of the field trials. They provide space to grade each trial and an area to describe any discrepancies encountered.

Summative

Once the learning system was delivered to the customer, in this case the Grumman E-Beam Systems Group, a summative evaluation was planned. The designers chose to use the Kirkpatrick (1987) model for summative evaluation. In this method, the total system is evaluated at four different levels: reaction, learning, behavior, and results.

Reaction. It was important to the developers that the reaction of the end-users to the computer-based system was favorable. Enthusiasm leads to motivation and that leads to increased learning. The designers chose to use a survey to determine the reaction and document it. The reaction information would be used to make improvements to the existing system and to guide development of future IVD/CBT systems. A reaction survey/questionnaire was developed that would assess the user's reaction based on prior experience with e-beam systems. The designers hoped to show that the users liked the system and that the users felt it would be a useful training device. Suggestions as to how to design the survey were obtained from Wimmer and Dominick (1987) and Phillips (1983). Specific questions were suggested by the U.S. Army interactive courseware development guide, TRADOC Circular 351-88-1.

Learning. Measurable increases in knowledge would satisfy the second summative evaluation level, learning. Since neither the training module or the job aid would contain tests, no hard data about learning would be generated during implementation. Observation would be the easiest, if not the only way to determine if learning occurred as a result of the training module. If a job aid user was observed accessing the lowest level of detail for the beam alignment procedure, it could be assumed that learning did not take place. Quantifying the learning that takes place as a result of using the job aid would be difficult if not impossible. The basic premise of this project was that many members of the target population would not be able to perform some of the procedures without the job aid. If the job aid could enable the user to perform an objective, it could be said that the equivalent of learning had taken place. Once again, observation is the only way to determine this.

Behavior. If the training and job aid are technically correct, and the system is used by the e-beam systems personnel, it could expected to see the desired behavior exhibited by the population. That was essentially the purpose of this project. Measuring this behavior had to be the responsibility of the E-Beam Systems Group program management. The only way this can be done is by direct observation. The designers planned to give paper copies of the task lists to the various managers at e-beam systems so they would know exactly what tasks the job aid can enable to help them evaluate this aspect.

Results. At the last level, results, or the impact on the bottom line, is the yardstick. If the Grumman delivery schedule is accelerated, then clearly the results are positive. Historically, the cost of training has been determined based on a development cost per hour-of-instruction ratio. This may be a good way to evaluate the cost effectiveness of traditional educational programs in a school environment but it is not appropriate in this case for two reasons. First, no one user is likely to utilize all of the job aid. Each user will need help with different aspects of the job. Secondly, the increased productivity that results from the training and the job aid offsets the cost of development. Quantifying the impact involves a cost-performance analysis based on the total cost of the training program compared to the savings effected on the integration schedule. The job aid should provide for increased performance on the job. Quantifying that increase will be difficult for the designers to do within Grumman and impossible at IBM, should the system be implemented there. The designers will attempt to estimate a rate of return on investment as a tool for management to market the finished system.

Learning Transfer System Specification

Transfer of training is defined as the ability of the learner to use the skills acquired in the learning environment on the job, in the work environment. For the need identified in the analysis phase, a very high degree of transfer was essential. Certain strategies were employed to ensure transfer of learning from the training environment to the actual equipment. Beaudin (1987) describes training as a continuum of events starting well before the training takes place, continuing through the actual training and into the post-training, on-the-job environment. Broad (1982) elaborates further, recommending steps to be taken by the supervisors, trainers and trainees to insure transfer of learning. The developers considered their suggestions and adapted those that were applicable to this project, keeping in mind the small size of the target group, the capabilities of the IVD/CBT delivery system and the nature of the material to be taught.

Before Training

Right from the start, at the needs assesment, it is important to include everyone who will be affected by the training. This includes management, supervisors, members of the target population and the training developers. A visible commitment by management will help the development of training immeasureably. Input from management should include not only training requirements, but firm commitment to schedule and use of necessary facilities. Feedback from the designers to management is essential as well. It is important that the designers demonstrate to management, and to all other participants, what can be gained by training. Similarly, the designers are responsible for making sure everyone understands clearly what training will and will not do for the organization.

During Training

During training there are many tried and true strategies to enhance transfer of learning. Alessi (1988) recommends simulation for learning procedural tasks as a way to enhance transfer of learning. Practice and feedback is the traditional method to enhance transfer and are a large part of virtually any learning situation. Simulation is the ideal means to allow practice and feedback in a no-risk situation. Involving the learner in the learning process is recognized as another method of promoting both transfer and motivation. The interactive system allows for maximum involvement by the learner, from decision-making to actual hands-on participation. In addition to the transfer enhancement strategies in the simulation, the final learning activity, 5.0, shown in Table 5, is to be performed with the job aid. This provides for a transition from the simulation to the job aid and actual equipment.

After Training

One way to guarantee complete transfer of learning is to provide the learner with a job aid to refer to when back in the workplace (Beaudin, 1987). The designers chose to make a job aid the foundation of the project. But beyond the job aid there are other considerations. Job incumbents must be encouraged to use the system by management. Similarly, new hires must be supported by their peers and encouraged to use the training and job aid. It is the new hire who stands to make the most beneficial use of this system.

Review and Selection of Existing Material

Unfortunately, there was no existing training material at all to select from. This project is the first formalized training of any type for this job. The only existing material that was used was an update to a users guide for the Alignment Servo Firmware (1987).

Summary

An instructional task analysis was done for the beam alignment procedure. Learning objectives were made for the training module and level of detail guidelines were established for the job aid. Instructional activities including simulation were designed for interactive computer-based delivery based on cognitive and behavioral psychology to achieve the learning objectives. Plans were made to assess the quality of the training from the learners perspective and the transfer of that training to the job environment. Additionally, a plan was made to assess the value of the training from the organizations perspective.

CHAPTER 4

DEVELOPMENT

Introduction

The development phase is where the designers see the framework built in the design phase begin to take its intended form. The project becomes something tangible that can be used as planned and evaluated. This point, in most projects, is "the fun part." What is generally regarded as "the hard part" is over. It was during this development phase that the designers faced their greatest challenges. As the great philosopher Murphy stated, "The likelyhood of something going wrong is directly related to its relative importance to the endeavor." Some of the problems the designers encountered could not have been forseen. Some were foreseeable but remained unseen. This chapter describes the development process for interactive videodisc computer based training (IVD/CBT) systems and problems that are common for the learning activity development stage.

Learning Activity Development Scheme

At this point in the project, all of the pieces were in place to begin the production of the actual training materials. All the necessary information had been gathered, it had been analyzed and organized, a program had been designed based on modern learning theory, and the storyboards and flowcharts had been created. In a parallel effort, the IBM hardware and software that would be used for development and implementation had been ordered. The designers had to take these outputs from the design phase and turn them into materials for implementation. The development of IBM InfoWindows IVD/CBT involves processes unique to that system. Figure 2 is a flow diagram of a typical development scheme for an IBM InfoWindows IVD/CBT project. The development scheme for this project included five major tasks that had to be accomplished.

1. Creation of course outline, off-line with Wordstar.
2. Set-up of InfoWindow delivery hardware and integration with the IWPS Editor development software.
3. Creation of the lesson software (courseware) with the IWPS Editor software on the delivery hardware.
4. Production of the videodisc master tape.
5. Formative evaluation of integrated system; videodisc, courseware and delivery hardware, and subsequent revision.

One problem that surfaced was one that could have been foreseen. The project had been organized as what Larsen (1989) refers to as a productivity-oriented project, when it really should have incorporated some lattitude for experimentally-oriented work. Ordinarily when developing IVD/CBT, the people that perform the analysis and design work are not responsible for the development work. The skills required to do programming and video production are unrelated to the skills one needs to perform analysis and design. In this case, the designers were responsible for the development. One of the designers who was experienced with authoring systems was tasked to become proficient with the InfoWindow Editor software. The designers attempted to arrange for formal training from IBM on the InfoWindows system, however, none was available that was

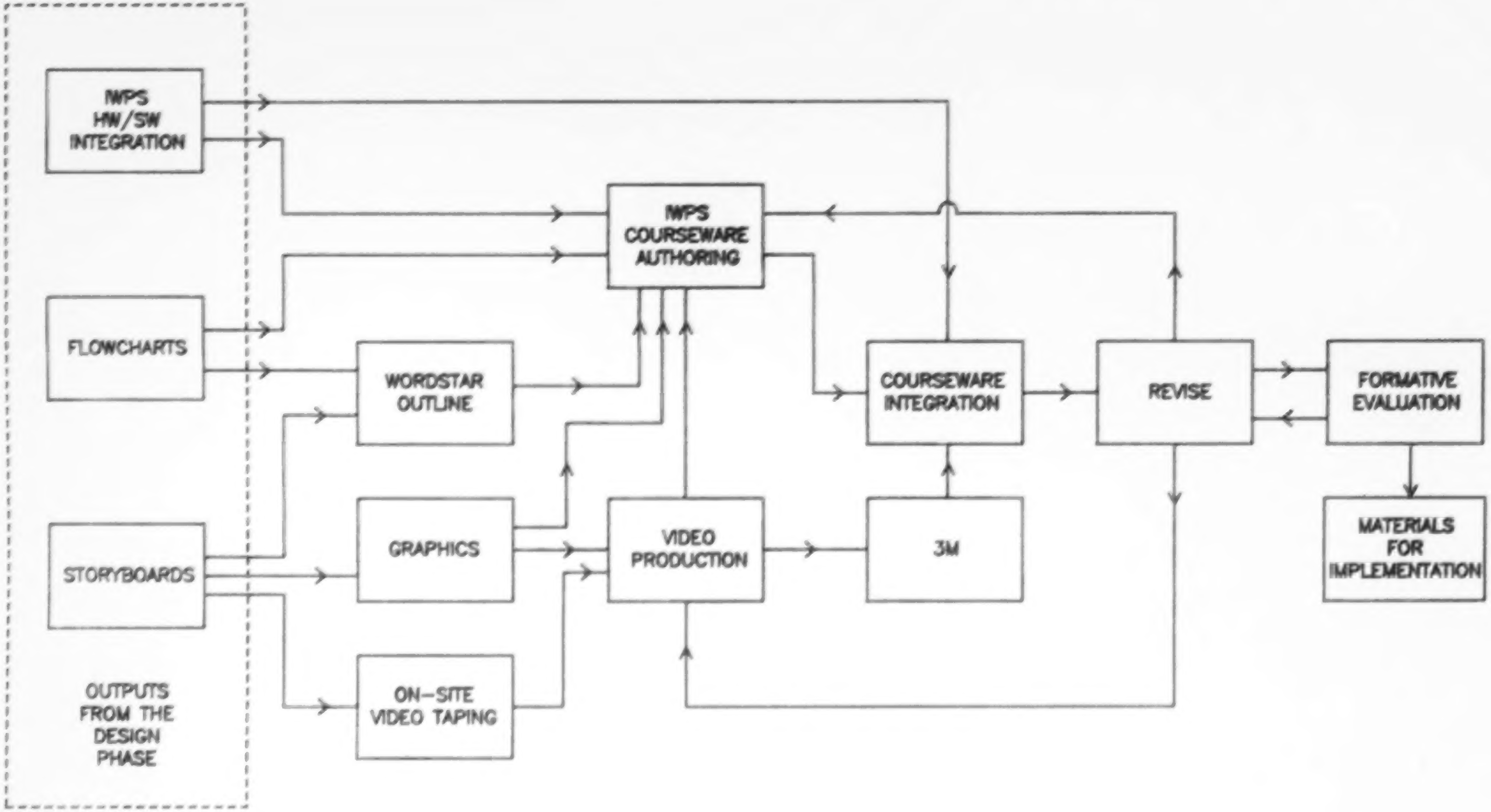

IWPS
HW/SW
INTEGRATION
IWPS
COURSEWARE
AUTHORING
FLOWCHARTS
WORDSTAR
OUTLINE
COURSEWARE
INTEGRATION
REVISE
FORMATIVE
EVALUATION
STORYBOARDS
GRAPHICS
VIDEO
PRODUCTION
3M
MATERIALS
FOR
IMPLEMENTATION
ON-SITE
VIDEO TAPING
OUTPUTS
FROM THE
DESIGN
PHASE

FIGURE 2. FLOW DIAGRAM FOR IBM INFOWINDOW
IVD/CBT SYSTEM DEVELOPMENT PHASE

appropriate. The author was responsible for the video production and served as the camera operator and tape editor. Fortunately, he was experienced at video production. The other tasks required no special expertise. The designers did not anticipate any problems with this development scheme.

Learning Activity Development

The designers set about accomplishing the five tasks that lay before them. A discussion of what transpired follows.

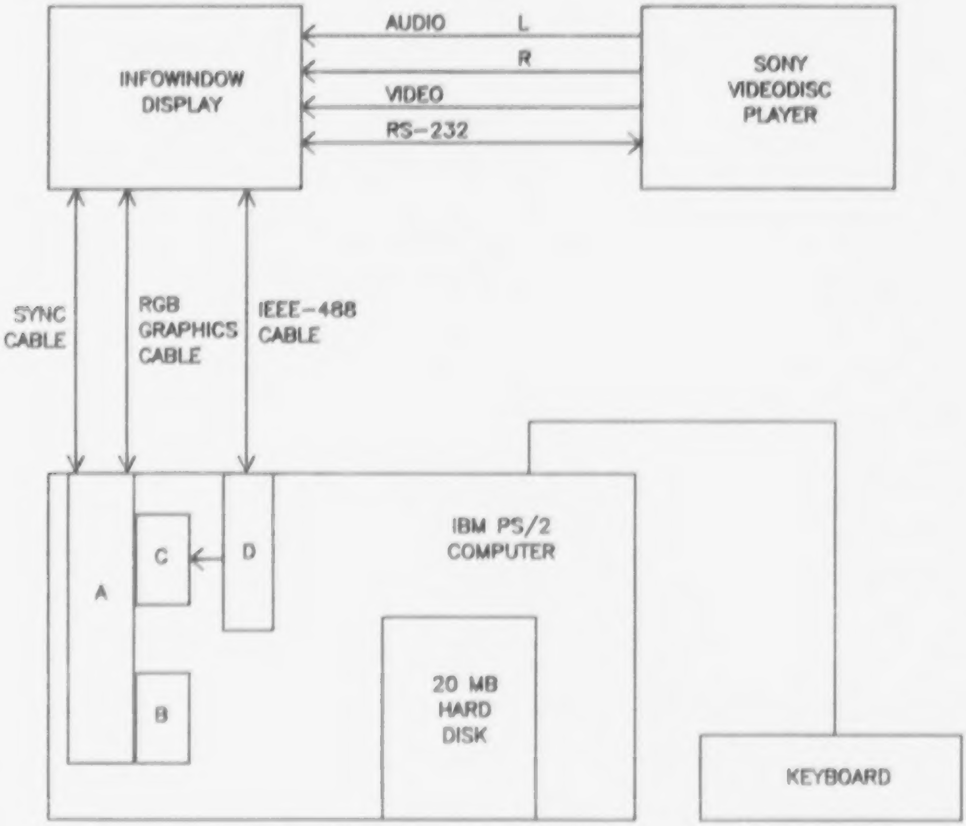
1. Creation of the Course Outline

Staying within the constraints placed on the project, the developers had selected the IBM InfoWindow Presentation System Editor and Interpreter (IWPS Editor) as the authoring system. The IWPS Editor has certain restrictions within it that require the developer to perform specific steps in order to make full use of its capabilities. The most important of these steps is the creation of an outline of the lesson. "The outline is the backbone of a presentation. It is used by the...editor to manage the authoring process" (IBM, 1987). In order to create an "event" with the IWPS Editor software, a corresponding event must exist in an outline. The outline can be created on any MS-DOS based computer using a word processor that will create an ASCII file. Wordstar, the word processing program, was used for this purpose. For the job performance aid, the actual step list was created with Wordstar and was designed from the beginning to be used as a starting point for the outline. Similarly, for the training module, an outline had to be created. The outline for the training module appears in Appendix G. The finished outline is "imported" to the IWPS Editor and courseware authoring can begin.

2. Integration of InfoWindow Hardware and Software

Due to organizational constraints the system chosen for the implementation of the training and the job aid was the IBM InfoWindow Presentation System (IWPS). A block diagram of the IWPS hardware and software appears in Figure 3. For a more detailed list of the components that make up the system, see Appendix D. When working with so-called state-of-the-art technology, one tends to forget that, despite the glamour, one must still be concious of limitations. The limitations can manifest themselves in many ways, not the least of which is simply availability of the equipment. The developers of this program were aware that the schedule was ambitious and that obtaining the hardware in time to allow for learning the software was going to be a problem. It was hoped that the designer assigned to the lesson programming with the IWPS Editor attend an IWPS users school, however, no scheduled classes were convenient. The designers were faced with integrating their system and learning how to use it on their own. This turned out to be quite an experience. In order for the InfoWindow Editor software to run, all the IWPS hardware must be present. Without the IWPS Display monitor, courseware can be developed but not run and debugged. The original schedule specified hardware delivery to the designers in mid-June in order to meet the schedule. Near the end of July, IBM informed the designers that they could not deliver the InfoWindow Display until mid-October due to backlog

FIGURE 3. INFOWINDOW PRESENTATION SYSTEM BLOCK DIAGRAM


INFOWINDOW DISPLAY
AUDIO L
R
VIDEO
RS-232
SONY VIDEODISC PLAYER
SYNC CABLE
RGB GRAPHICS CABLE
IEEE-488 CABLE
A
B
C
D
IBM PS/2 COMPUTER
20 MB HARD DISK
KEYBOARD

COMPUTER SPECIFICATIONS

640 KB RAM
20 MB HARD DRIVE
A. INFOWINDOW EGA CARD
B. EXPANDED GRAPHICS MEMORY
C. GPIB ADAPTER CARD
D. GPIB INTERFACE CARD

SOFTWARE

1) INFOWINDOW PRESENTATION SYSTEM EDITOR
2) INFOWINDOW PRESENTATION SYSTEM INTERPRETER
3) INFOWINDOW CONTROL PROGRAM
4) IBM DOS 4.0

PERIPHERALS

INFOWINDOW DISPLAY MONITOR WITH TOUCH SCREEN
SONY LDP-1500 VIDEODISC PLAYER

of orders. Eventually, an agreement was made for IBM to supply a "loaner" display to Simulation/Trainer Products. The loaner was received during the first week of September. The designers no longer had the luxury of "learning by doing" with the IWPS Editor. The designers had been busy all summer creating the outlines and courseware that could not be tested. It was hoped that with minor changes the existing courseware would run. Upon installing the software and running the courseware, more problems were discovered. In the world of computers and electronics, things evolve and change with blinding speed. What is the latest and greatest today is often obsolete before the market can grasp it. The IWPS Editor software that the designers were using was a very old version, Rev. 11. The current version, that they should have received, was Rev. 51. The difference between the two numbers is a fair approximation of the difference between the two versions. The differences were so vast that the software was not upwardly compatable. In simpler terms, it was useless. More importantly, the progress that was made up the learning curve using the old IWPS Editor software was not applicable to the newer version. The new version offered new development tools and options that made most of the experience gained on the old version obsolete. Essentially, two months of work by the courseware programmer were lost. The problem with the software versions could not have been discovered until the IWPS display was received. IBM shipped the designers the new IWPS Editor software. The schedule was thrown out and re-made and an ambitious recovery program was undertaken.

3. Courseware Authoring

The IWPS Editor is an authoring system as opposed to an authoring language. An authoring language is similar to a conventional programming language. Authoring with one is very much like writing a program with a language like BASIC or Pascal. In general authoring systems are comparitively user-friendly application packages that require no special expertise to use. That is a good description of the IWPS Editor. However, it is an extremely versatile, powerful system that offers the user many tools with which a developer can implement various instructional strategies. Essentially, authoring is simply using the available tools to implement the instructional design. The designers used the storyboards and the flowcharts created in the design phase as the authoring plan. The storyboards are the script for the visual aspects of the delivery. Based on those, the courseware programmer creates the text messages, the overlays for the video and the simpler graphics and specifies where on the screen they are to appear. The flowcharts are the script for the branching. The courseware programmer defines active touch areas on each screen and defines what path the instruction takes when each touch is detected. Additionally, the courseware programmer defines other aspects of the presentation such as the type of transition between screens (i.e. wipes, dissolves) and touch acknowledgements (i.e. good beep, change color). The IWPS Editor features a printout function that lists the various parameters defined for each event. A printout of the IWPS presentation documentation for the training module appears in Appendix H.

4. Videodisc Production

Producing a videodisc is an elaborate process that requires sophisticated, expensive equipment as well as experienced personnel to operate it. It was planned that the storyboards created to aid in the analysis phase would become the "shot-sheets" or video production script. The shot-sheets precisely described the visual material that was needed for the project, both video taped and graphics to be created by an artist. Ordinarily, an audio script would be made at this point, but due to a design compromise, the audio capability of the medium was not used. The methods and techniques involved with a video production are beyond the scope of this discussion. However, a brief description of the process is necessary to understand the development process. The video production crew took the shot-sheets and the video recording equipment to the Grumman E-Beam Systems Integration Lab. The specified shots were set-up and recorded, one at a time, onto a 3/4" U-Matic video tape. As the tape was recorded, a timecode generator built into the recording deck, assigned an electronic address to each and every frame of video. Notes were taken by the production crew, that used these time code numbers as a reference. Unfortunately, EBL device number twenty-seven was fully calibrated and running for final delivery inspection by IBM. It was decided by management that the system would not be misadjusted or recalibrated for the sake of the video. This prevented the videotaping of several portions of the operation needed for the job aid. Plans had to be made to make-do without them. The videotape was brought back to the post-production facility at the Simulation/Trainer Products Video Lab, for editing. While the on-site production was taking place, the Simulation/Trainer Products artist was busy creating video graphics as specified by the designers. With the help of a computer-assisted editing system, the video shots and graphics were edited on to 1" Type-C video tape. This tape is known as the "master." A "map" had to be made of the videodisc so that the specific visuals can be found later during integration. The computer-assisted editor keeps a record, by timecode numbers, of the edit in and out points. This record is known as the edit decision list, or EDL. Once the editing is completed, the EDL was converted automatically to the proper videodisc frame numbers. The frame numbers are supplied to the courseware author for inclusion in the software. The converted edit decision list is included in Appendix I. When the master tape was finished, it was checked for completeness against the shot sheets and then duplicated for safety. The actual conversion from video tape to videodisc was done by 3M Optical Recording in Menomonie, Wisconsin. The first version of the master tape was made into a "check disc." The check disc was used to integrate and validate the courseware. The master tape was returned to Grumman for modification if necessary.

5. Courseware Validation

During the validation the check disc is used with the first draft courseware to test the program for obvious errors. The designers review the various aspects of the presentation for inconsistencies, ease of use, branching and instructional strategies. One module that was representative of the job aid was fully implemented to help the designers establish a baseline for further development. It also provided something that management could see and touch. The importance of this should not be overlooked. To the developer however, the purpose at this stage, is not to determine training effectiveness, but to evaluate suitability of strategies employed and identify obvious errors. One problem was identified immediately. Many of the graphics done by the artist were of the control panels for the various FRUs. Some of them have many knobs, switches and indicators that were difficult to depict on one video screen. It turned out that the lettering on the graphics was illegible when played back from the videodisc. It looked perfectly legible to the artist working on a high-resolution RGB monitor. However, by the time it was converted to NTSC video and then degraded two generations (first to the master tape, second from tape to disc) it was no longer satisfactory. This is why a check disc is ordered. These types of problems are fixed before the production discs are ordered. Before the job aid could be evaluated in terms of the objectives, the designers needed to verify the technical accuracy of the step lists as implemented in the job aid. At this stage, the evaluation is conducted by subject matter experts as opposed to members of the target population. The designers expected to find a large number of significant errors in the implementation and the simplest way to identify them was to have an expert point them out. The terminal learning objectives had been broken down into enabling objectives which were further broken down into step lists. The step lists were converted almost verbatim into the computer-based delivery media for both the job aid and the training module. If the step lists were not accurate, the job aid could not possibly enable the terminal objectives. The overall accuracy of the step lists were based on many criteria: proper description of each of the procedures, the correct order of the steps, correctness and consistancy of terminology, even spelling and grammar. The visual aids also had to be verified for correctness. At this stage, the job aid included the videodisc-based video and graphics. The waveforms also had to be evaluated for technical accuracy. Was the waveform on videodisc frame 6810 really the waveform for a good filament profile? These types of questions could only be answered by an expert on the EL-3 system. Due to the prototypical nature of EBL device number 27, which was an EL-3+, and significantly different from an EL-3, many questions could not be answered, even by an expert. Verification could only be done by comparison to an actual EL-3+ device. As the development phase neared completion, the job aid system was brought to the Grumman E-Beam Systems Integration Lab and set-up near an EL-3 device for further evaluation.

Configuration Management

The designers realized that they needed a system or methodology to implement changes to the job aid. The task list, the training module and the job aid are all interrelated. If there was a problem with the job aid, then the task list may have been wrong and the training module may have been wrong as well.

When a change was to be made, the task list was changed first, then the outline for the training module and the outline for the job aid. Finally, the IWPS code for the training module and the job aid were changed as necessary. This was a relatively simple process at the current level of implementation. But what would it be like to make changes later when the training and job aid are fully developed and being used for many tasks at different locations? The methodology for maintaining accuracy and currency between many aspects of a project is known as configuration management.

> Configuration management (CM) is the means for controlling the products we generate. It is one of those strange things that, like teaching children rules of behavior, we do whether we do it or not. The sheer act of generating products will require us to format them, control them, and manage them in some way. But if we don't do an effective job of it, we typically find that we have big problems when we try to maintain it. (Meyers, 1989).

The designers investigated methods to insure that future changes could be made easily and with a minimum of confusion. A form for reporting discrepancies, as suggested by Meyers (1989), was developed. Each step in the step list had been assigned a number. The designers used those numbers to identify steps in the training module and the job aid. For example, step 3.1.1 of the step list; set meter select switch to 2A, is event 3.1.1 in the IWPS outline and the IWPS courseware for the training module. The designers modified the job aid to include a display of the step number to make the reporting of a discrepancy as accurate as possible. A designer is assigned the responsibility of insuring that every aspect of the presentation is modified as required. This system makes it easy to change the presentation, and should make it easy for future support personnel to maintain the accuracy and currency of the presentations.

Learning Activity Review

On 10 October 1989, the first fully developed job aid module was demonstrated for both the Vice-President and the Director of Engineering of Simulation/Trainer Products. They both expressed satisfaction at the quality of the work and the resourcefulness of the developers. On 23 October 1989, the system was demonstrated to the Director of E-Beam Systems. He stated that it fit well into the plan to support the EL-3 system beyond technical expertise. He expressed optimism that this system would have a market with the users of the EL-3. The most welcome sentiment he expressed was that the work was good and that despite the schedule problems, the budget looked good and we should continue the development and evaluation.

Materials for Formative Evaluation Produced

Changes that were identified during validation were made to the videodisc master tape. Once again, the tape was duplicated for safety. The final master was sent to 3M for the final production disc mastering. The presentation software was copied and printouts of the outline, the IWPS code, and the flowcharts were gathered for the evaluation.

Summary

The development of the materials for implementation occurred in five stages; creation of the course outline, integration of the InfoWindows hardware and software, creation of the videodisc, creation of the lesson software, and formative evaluation. Several problems were encountered that were typical of this type of project. These problems were resolved and the preparations for the evaluation phase were complete.

CHAPTER 5

IMPLEMENTATION

Introduction

The implementation phase represents the end of the development cycle and the beginning of the actual use of the training in the way it was designed to be used. In the case of this project, that meant delivery to the customer, Grumman Electronics Systems Division, E-Beam Systems Group. During the first week of December, 1989, the system was set-up in the E-Beam Systems Group Integration Lab at Grummans' Great River Operations Center, Great River, N.Y. A formative evaluation began at this time. Based on the results of the evaluation process, modifications were made to the training and job aid system. When the evaluation and modifications were complete, the designers turned the materials for implementation over to the customer for operational use. A description of the final implementation of both the training module and the job aid are given. The final delivery took place during the second week of April, 1990. At that time, the designers initiated a management plan for the use of the system that included operational instructions and materials for collecting data about the system.

Materials for Implementation Reproduced

Upon completion of the formative evaluation, a final version of the job aid software was made called Version 1.0. Since there was only one set of delivery hardware, only four copies were produced. The first, was produced for the actual delivery on the

InfoWindow system. A second copy was made as a safety backup in case of accidental erasure or other computer problem. For archival purposes, a third copy to be retained in the Simulation/Trainer Products Configuration Data Library was made. The fourth was to be retained by the Department of Training and Learning Technology at the New York Institute of Technology (NYIT). Ten replicates of the the final version of the videodisc were obtained from 3M. Five were delivered with the system and four were retained by Simulation/Trainer Products for demonstration and archival purposes. One copy was given to NYIT to accompany the software. For further information concerning the courseware, see Appendix J.

A "batch file" was created in the deliverable computer operating system that configured the computer to execute the instructional package directly from start-up. A users' guide was produced by the designers which included a delivery system (hardware) block diagram. A copy of the users' guide appears in Appendix K. All original packing and shipping material for the hardware was delivered to the customer as well.

Instructional Delivery

The following is a description of both the training module and the job aid, as it would be viewed by a user. The user makes all responses to the system by touching the InfoWindow Display screen.

System Start-Up

The job aid and the training module both start-up the same way. Upon turning the power on to the IVD/CBT system, a DOS batch file initializes all the peripheral equipment including the videodisc player and the touch screen. This is done without input from the user other than turning the power on. When the system is ready, the computer directs the videodisc player to go to the starting sequence. The title "EL-3" is shown with the prompt "Touch Screen to Start Lesson." Upon sensing a screen touch by the user, the computer directs the videodisc player to play the animated sequence described in Chapter Three. The sequence ends with the main menu. The user has the option to select the job aid or the training module. The job aid is described first.

Job Performance Aid

The job aid was implemented as described by the level of detail guidelines, established during the design phase. A general description of the job aid follows, based on the three categories identified; discriminations and perceptions, problem solving and decision making, and motor actions. Branching strategies are included as part of the decision making process.

Discriminations and Perceptions. Whenever the procedure calls for examination of an oscilloscope waveform during the set-up, the job aid displays video of the proper waveform. Similarly, the job aid gives sample readings for the other displays. The samples correspond closely to what can be expected on the actual equipment.

Problem Solving and Decision Making. There are two types of branching schemes employed in the job aid, those based on problem solving and those based on decision making. For problem solving procedures, the user is shown several typical waveforms and has to select the one that most closely resembles the one displayed by the actual equipment. If the user selects the "good" waveform, the job aid branches to the next step in the procedure. If a sample "bad" waveform is selected, the user is given directions to make the appropriate corrections. For example, see Appendix B, enabling objective 3.5, "Check Filament Profile." The learner is told how to check the filament profile and is given visual aids as criteria to compare the actual waveform to. The job aid branches depending on the user's input. If the user responds that the beam profile is not correct, directions are given to make a typical correction, align anode. If that corrects the problem, the user continues with the procedure. If it does not, the user is directed to try a second remedy, adjust heater/emission current. If the profile is still bad after that, the user is directed to replace the beam filament and start the alignment procedures over again. The remainder of the procedures feature branching based on decision making. Within this type, the designers incorporated two possible branching strategies. The first is a user-controlled, menu-driven strategy. The user can select any of the five available procedures. The menu options give an experienced user the ability to jump directly to a specific procedure. If the user does not use the menu option, a default branching strategy will guide the user, in a linear path, from start to finish through the five terminal learning objectives.

Motor Actions. The job aid offers directions for the proper switch settings on the actual equipment. Additionally, the location of both the component and the individual switches and adjustments are given.

The Training Module

It is important to remember that the training module was developed as a demonstration only. The purpose of the training module was to show how training could increase the efficiency of the job aid. The training module, like the job aid, is entirely touch-driven. The training module branching is entirely based on the decisions of the learner. A description of the five learning activities follows.

Learning Activity 1.0. The objective of the first learning activity is to define the concepts that the learner will encounter in learning activities three and four. The training module begins with a repeat of the video animation sequence to gain the learner's attention. Following the animation the learner is told the objective of the lesson and is given instructions on how to use the system. The lesson is a linear tutorial on the definition of alignment in the context of the e-beam system. Several video and graphic images are used to motivate the learner and to aid encoding. The learner encounters an embedded quiz on three-dimensional coordinates. The learner is shown a view of several points plotted in three-dimensional space. The learner must identify two different points from the text description given. To do this, the learner simply touches points on the screen. No remediation is supplied for incorrect answers. Upon completion of the quiz the learner branches to the second learning activity.

Learning Activity 2.0. The second lesson explains in a linear, tutorial fashion, the verbal knowledge about the alignment brightness FRU that the learner will need for learning activities three and four. The lesson objective is given on the first screen. The learner then proceeds through a series of screens that highlight each relevant key or switch. One by one the learner is told what each key does. No tests are used in either of the first two learning activities. The learner is asked if he or she would like to repeat any part of the tutorial. If not, they will proceed to learning activity three.

Learning Activity 3.0. Lesson three begins the computer-based simulation. The learner must perform learning objective 3.0, "Set 2nd Alignment to One Side" according to the criteria specified by the job performance measure as shown in Table 5. An introduction page informs the learner of the objective. The second screen the learner sees supplies instructions as to how the simulation works and how to get help. The learner is shown a two-dimensional representation of the alignment brightness FRU (ABF) keypad and display. The keypad is larger than the actual equipment to allow use of the touch screen with a minimum of touch errors. The various keys that are relevant to the learning activity are all active. Touching them will result in the appropriate response on the ABF display (natural feedback). If the learner knows the procedure, he or she can perform it without any prompting. The learner may choose to follow prompts to see how to complete the procedure. The learner can ask for a hint by touching the NEXT area. If necessary, the learner can ask specifically what the next step is by touching HELP. The learner has the option at any time to perform the next step without being prompted. When the learner can perform the entire procedure completely without the prompts, he or she has sufficiently mastered the objective.

Learning Activity 4.0. The learner must perform learning objective 3.2.2, "Minimize 2nd Aperture Reading" according to the criteria specified by the job performance measure. The lesson is similar in structure and appearance to lesson three. The learner is first shown an objective page. As in lesson three, the learner follows the prompts until the objective has been mastered. When the learner exits learning activity four, the courseware branches to the job aid software.

Learning Activity 5.0. The learner must use the job aid to accomplish learning objective 3.1, "Align 1st Aperture." This is a suggested learning activity and depends entirely on the availability of a fully functional EL-3 device. The simulation is no longer used for this step. The job aid assists the user on the actual equipment. The designers felt that if this step was possible it would enhance transfer of training.

Data Collection

Each of the Grumman personnel who participated in the field trials was given a survey questionnaire to help the designers judge the reaction to the training and job aid system. The designers also relied heavily on observation during the field trials to gather data. In an effort to remove subjectivity, the designers followed guidelines established during the design phase. Since neither the training nor the job aid involved any form of testing, there was no way to gather hard data about the results. There was no training program in place previously with which to compare data. The designers felt that if the job aid enabled the test population to perform the objectives, then one hundred percent mastery could be considered.

Summary

The materials for implementation were reproduced and delivered to the customer. All other materials that were contracted for, such as a users' guide were turned over to the customer as well. The management plan for actual use of the system was initiated at this time. Additionally, material for gathering data about the training and job aid system were distributed to the customer.

CHAPTER 6

EVALUATION

Introduction

Although the evaluation of the project is described last, it is not to be implied that it is done after the training is implemented. Evaluation is an ongoing process throughout the entire project. Dick and Carey (1985) call this the evaluation phase, with a formative stage and a summative stage. The interservice ISD model refers to this as the control phase, with an internal and external component (Branson, et al., 1976). Meyers (1989) refers to this as a maintenance phase. Despite the difference in terminology, the approach and methodology are essentially identical. It is a total quality control process for the training that feeds information back to every phase of the training development. For this project, the Dick and Carey (1985) model was used. A formative evaluation was conducted during the development phase, and a summative evaluation was conducted, beginning with, and continuing throughout the duration of implementation.

Formative Evaluation

A formative evaluation is conducted during the development phase to determine if the training being created will meet the instructional objectives set by the designers. The objective of the job performance aid was to enable a user to accomplish the terminal learning objectives identified in the analysis phase. The objective of the training module was to enable more efficient use of the job aid. The formative evaluation was designed and conducted to determine if the job performance aid and the training module accomplished these goals. The InfoWindow delivery system was set-up at the E-Beam Systems Integration Lab at Great River, N.Y. and the formative evaluation began.

One-on-One Trials

When the designers felt that the technical accuracy of the training and job aid system was at a satisfactory level, a series of five formal one-on-one trials were conducted. Both the job aid and the training were intended to be used by one, perhaps two people at a time during implementation, so the feedback obtained during the one-on-one trials was very important to the designers. Dick and Carey (1985) suggest using the one-on-one trials to remove the most obvious errors and obtain initial reactions from the users. The designers selected several members of the e-beam systems group for the one-on-one evaluation that had skill levels similar to the target population; familiarity with the e-beam system but no in-depth knowledge of the alignment procedures. Additionally, the designers utilized a subject matter expert to assist in the identification of technical errors. The designers sat side-by-side with each subject and observed the actions of the user. The designers encouraged the test subjects to give feedback to them. Notes were taken during the observations and during debriefings conducted after the trial. No formal criteria had been developed for this phase of evaluation. The plan was to identify and correct gross discrepancies and to get the system close to a condition where a formal evaluation was appropriate.

This phase of the evaluation made no attempt to determine any performance outcomes. Several modifications were made to the delivery presentation as a result of the one-on-one evaluations. They are listed below:

1. When the delivery depends on self-instruction, it is very important that the user is not confused or frustrated by the use of the media. Within the job aid, the color and location of the on-screen instructions had to be changed. The users seemed to confuse directions such as "touch next to continue" with steps in the procedure being performed. The text color for all such instructions was changed to magenta and the on-screen location was changed to line twenty-two on the screen, immediately above the BACK/NEXT/MENU touch locations.

2. A second problem surfaced related to the branching. Some of the detailed information presented by the job aid, such as the location of a component or the position of a switch required two or three touches to access. The users appeared frustrated at not receiving the information directly, but having to touch "help" first, then touching the name of the component or switch. It became apparent that the location of the components was not used often but the switch positions were. Wherever it was possible, the designers changed the branching to show the user the switch positions with one touch. The locations of components, in most cases remains at a level that requires two touches.

3. It is important to remember that every aspect of the presentation implementation be evaluated. It became apparent

that the users were having difficulty reporting discrepancies to the designers with the existing methodology. The designers modified the job aid presentation to include the step number from the step list as part of the display, to make the reporting of a discrepancy as simple and accurate as possible. This system makes it easy to change the presentation, and should make it easy for future support personnel to maintain the accuracy and currency of the presentations.

4. Many technical inacuracies were uncovered during this phase as well. The constant evolution of the e-beam system set-up procedures combined with differing personal methods among the SME's led to many minor changes, the specifics of which need not be discussed here. This had been, and continued to be a problem throughout the duration of the project.

Small Group Trials

Due to the small size of the target population and the nature of computer-based training, formal small group trials were not scheduled. The job aid and training module were meant to be used by one person at a time, perhaps two at most. Many times though, during the course of the evaluation, two users would collaborate on the system. The designers observed that this seemed to enhance the performance of both users.

Field Trials

When the designers felt that the system was ready, field trials were conducted at the E-Beam Systems Integration Lab with Grumman personnel. A field trial was the last step of the formative evaluation. By this time, the materials being evaluated were refined to a high degree. The designers were now confident in the technical accuracy and the useability of the job aid. What remained was to prove that the job aid could, in fact, enable a user to accomplish the terminal learning objectives on the actual equipment. A complete description of the terminal learning objectives is given in Table 1. The designers encountered the same problem in the field trials that had been present throughout the evaluation, lack of a fully operational EL-3 and/or EL-3+ system to test the job aid against. Terminal learning objectives 7.0, 8.0, 9.0, 10.0, and 12.0, could not be evaluated. The technical accuracy of those portions of the job aid had never been verified and a fully functional EL-3+ device was required to evaluate them. Terminal objectives 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 11.0 could be assessed with an EL-3 device, however a fully functional EL-3 device was not available during the period of evaluation. To work around this problem, the designers chose to conduct the field trials in two steps. The first step was limited to evaluating the reaction of the users to the delivery system and method. The results of that aspect appear in the section on summative evaluation. The second step was to evaluate whether or not the instructional objectives could be met by the job aid. This had to be done separately by the designers and a subject matter expert without comparison to the actual operation of the actual equipment. The nature of the job aid and the actual job tasks were such that criterion referenced tests were not appropriate. The designers instead, had developed a simple pass/fail evaluation method described in

Chapter Three. Any task that had either a critical or a serious error would fail. Each terminal learning objective was analyzed to determine which enabling objectives were critical to the performance of that procedure. The results of that analysis for terminal learning objective 3.0 are listed in Table 9.

Table 9

Enabling Objectives for Evaluation in Field Trials
Terminal Learning Objective 3.0

Enabling Objective	Description
3.1	Align 1st Aperture
3.2	Align 2nd Aperture
3.3	Align 3rd Aperture
3.3.3	Find 3rd Aperture Center (Dither X/Y)
3.4	Align Sample Aperture
3.5	Get Filament Profile
3.6	Check Faraday Cup
3.8	Check Target Setting
3.10	Align Anode
3.11	Adjust Heater/Emission Current
3.12	Replace Filament

Each of the component learning objectives were evaluated individually. For each enabling objective specified in Table 10, the corresponding step list had to be proven. Appendix B contains the conditions, performance, and standards for the enabling objectives in Table 10. One subject matter expert who was considered the foremost authority on the beam column evaluated the step list. If the SME approved the procedure, then it could be considered that the system would enable mastery of the objective. A job aid that enables performance is essentially the same as the user learning the procedure with hundred percent transfer of training to the actual job. If a procedure was technically inaccurate, it could not enable mastery of the objective. Since the target was one hundred percent mastery for the terminal learning objectives that were being evaluated, any learning objective that failed required modification and re-evaluation. Each learning objective was evaluated in this manner four additional times by additional SMEs. The designers felt that if an enabling objective received five passes, it was certainly ready for implementation. If an enabling objective received a mix of passes and fails, the problem would probably be due to confusing or unorganized presentation. Additional study would have to be given to those procedures. The job aid directions might need to be reworded or the entry skills redefined. The designers had created evaluation forms with which the results of the field trials could be recorded. These forms provide space to grade each trial and an area to describe any discrepancies encountered. The results of the field trials for terminal learning objective 3.0 were disappointing to the designers. In summary, four of the eleven tasks contained serious errors that would prevent useful implementation of the job aid. The remaining seven had contained minor errors but were considered ready for implementation. There were no critical errors found. The completed evaluation forms appear in Appendix L, along with the corresponding discrepancy reports. One general deficiency was identified'in the delivery of the information, even at this late stage of development. The original job aid installation was on a desk approximately five feet away from the work area of an EBL system. This had not been a problem until this point. During the course of the field trials, the designers realized that there would be problems if the users had to constantly walk to and from the desk. This may seem trivial, but was not. At the most detailed level, there were hundreds of steps involved, even with the reduced scope of the field trials. The designers obtained a rolling cart and installed the job aid system on it. The users would then able to position the system wherever it was most convenient to work with.

The designers, once again, turned to the subject matter experts for corrections and the necessary changes were made. The tasks were re-evaluated to insure that one-hundred percent mastery had been achieved. Due to the fact that the procedures were not evaluated against actual equipment, an unanticipated problem arose in the evaluation. The different subject matter experts each had their own methods of "doing things." What was often construed as an error was merely a different way to do the same thing. An analogy would be giving a person directions how to drive from point A to point B. There are many ways to successfully arive at point B. Each way has its merits; less traffic, faster, better road, nice scenery, but each will get you to point B. The designers did not set out to implement the best way to get to "point B," just one possible way. If the steps had been evaluated against the actual equipment, this problem would not have arisen. Eventually one method for each procedure was settled on. A second field trial revealed that there were no longer any serious errors in the presentation.

Summative Evaluation

The summative evaluation involves the examination of the implementation of the fully developed program. Implementation of the training module and job aid had not been done at the time of this writing. The information presented in this segment was gathered during the field trials. Where no information was available, there is a description of what could be done and what the results might be. The summative evaluation was performed based on the Kirkpatrick (1987) model that features four levels of evaluation; reaction, learning, behavior, and results.

Reaction

The most important part of the summative evaluation for the developers was the reaction by the users to the system. The job aid was intended to be a useful tool but the training module was only intended to be a demonstration to show how training for the e-beam system could be implemented. The training module and job aid were combined into a demonstration package for the field trials. The user participated in learning activities one through five and then branched to the job aid for terminal learning objectives three and four. The designers were not present during this phase of evaluation. The sample group worked unsupervised with the user guide to approximate the actual conditions of implementation. Seven Grumman engineers participated in the field trials. The complete results appear in Appendix M.

Questions one through five were about the participants background. Six of the participants worked for Grumman Electronics Systems, one for Grumman Technical Services. Their average (mean) experience with e-beam systems was seven and one-half years with a median and mode of eight years. This was higher than anticipated for the target population. Their areas of specialization covered virtually all aspects of the e-beam system. All of the survey responses indicated a combination of formal education (college) and on-the-job training on the e-beam system.

Question six asked if the user felt that a system like this would have helped in learning the users area of specialization. All seven responded yes.

Question seven asked if the user would recommend to management the development of a similar training system for their area of specialization. Six responded yes and one did not respond.

The results of question eight were unanimous, none of the survey participants felt that the job aid would in any way threaten their job security.

In question nine, five of seven expressed willingness to participate as an SME for the development of a similar job aid for their area of specialization.

Questions ten through seventeen, given in Table 10, attempted to measure the reaction to the various instructional strategies employed in the training module and job aid. The survey used a scale from one to five, one being the most positive response. An index is given that represents the average response given for each question. In general, the responses were very positive for all strategies used. The sample was small and consequently it is difficult to draw definitive conclusions from the survey. However, the concept of training simulation and an on-line job aid was very well received. As a result of informal discussions with job incumbents during the evaluation, the designers decided to include additional questions on all future reaction surveys. These questions address the problem of maintaining proficiency once the skills have been mastered. In the absence of a means to practice their skills that are lost if not used frequently, the job aid may be a welcome means to maintain skill levels. A copy of the revised survey appears as

Table 10

Reaction Index for Instructional Strategies Employed

Question - Instructional Strategy	Reaction Index
10. What was your opinion of the simulation of the ABF keypad?	1.714
11. How helpful to you would a simulator have been when you were learning your job?	1.857
12. What was your opinion of the computer graphic representations of the beam?	1.571
13. How helpful to you would graphics or animations have been to you when you learned your job?	2.000
14. What was your opinion of the computer-based job aid?	1.571
15. How helpful would a written description of the steps involved in your job tasks be to you?	1.714
16. What was your opinion of the waveforms on the videodisc?	1.667
17. How helpful would a visual reference, such as the waveforms, be to you to for your job?	1.500

part of the users' guide in Appendix K.

Learning

The second level of the Kirkpatrick model evaluates whether the instructional objectives are enabled by the materials that are implemented. Ordinarily for a training program, this can be determined by a criterion referenced test based on the learning objectives. The majority of the objectives to be met by this program were to be enabled through the job aid. The designers, therefore, had to modify the definition of learning. If a user is able to perform a procedure with the help of the job aid that he or she was not able to perform without it, then the objective has been enabled. If the objective has been enabled, the equivalent of learning has taken place.

The training module was intended to be a demonstration only, to show how training could be used to complement the job aid, by enabling more efficient use of it. The developers felt that under those conditions, testing and scoring for the training module was not appropriate. Based on previous experience, a test during a demonstration can annoy a prospective customer. A positive reaction by the users to the concept of formal training on the e-beam system was integral to convincing Grumman management to continue the development effort. The reaction was very positive, especially in respect to the video graphics of the beam being deflected. The designers recommend that criterion-referenced testing be included in future versions of this training module, and all subsequent training modules.

Behavior

It was hoped by the developers that the Grumman e-beam systems engineers would use the job aid during the integration and set-up of future e-beam systems. This, it turned out, did not occur. Two reasons were identified. The first reason is due to the nature of the systems and the integration work. Number 27, the device that the job aid was modeled on, was unfortunately a one-of-a-kind system. Changes were made during the development of device number 27 that led to refinements in the design of the EBL system that were incorporated in subsequent systems. The procedures (TLOs) that were fully implemented were well known by the Grumman engineers. The small percentage of steps that changed included the steps that they could have used help with. The second reason is that the nature of systems integration work is investigative and diagnostic. The job aid was not intended to help a user troubleshoot a system. It was intended to help the user bring up a fully functional system to a ready-to-operate state. This is analagous to the daily and weekly checks that the military is required to perform on their weapons systems to insure proper operation. The job aid would be very useful to the operators and maintenance technicians at IBM who perform these tasks.

Results/Impact

The developers did not have access to the information necessary to evaluate the impact that the development and implementation of the job aid and training module had on Grumman. It could be assumed however from observation (behavior phase) that the impact due to the job aid, as of this writing, was negligible to Grumman. However, if implemented by IBM, the results could be significant. To demonstrate how results could be evaluated the designers created a hypothetical situation based on reasonable estimates. A graph depicting the hypothetical results appears in Figure 4. One of the important features of self-teaching packages is the fixed cost of development and minimal cost of maintenance (current funded total). There are no instructor salaries or building and facilities costs to include over the life of the training program so the cost of training remains constant over time. The savings however, steadily increase over time until a break-even point is reached. The hypothetical results in Figure 4 are based on a seventy-five dollar per hour labor rate for an engineer and a 240 day work year. If the job aid allowed an entry level engineer to perform set-up procedures for three hours without the assistance of an experienced engineer, that essentially makes the experienced engineer available for three extra hours. If that situation occurs once each day, then IBM could expect the job aid to pay for itself in a bit more than three years. This is a reasonable estimate based on the current level of implementation of the job aid, procedures one through four. If, on the other hand, an additional investment were made to fully develop and implement the remaining procedures, five through twelve (proposed funding level), the break-even point occurs sooner. Despite the increased cost of development, the user could expect to save money faster due to the availability of the experienced engineer

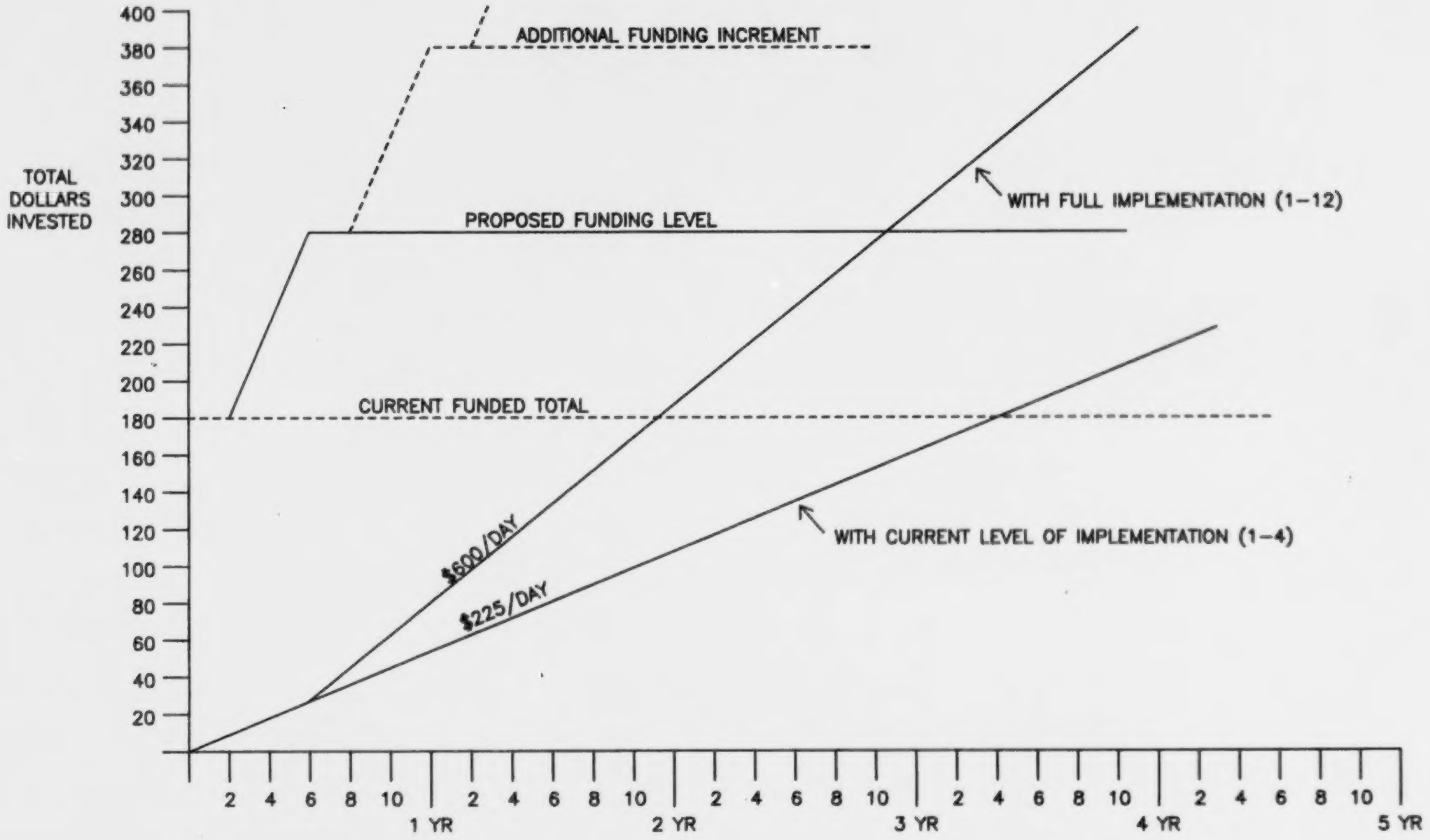


FIGURE 4. HYPOTHETICAL RATE OF RETURN ON INVESTMENT *.

* BASED ON 240 WORKDAYS/YEAR

115

116

for the full eight hours per day. Hypothetically, the increased rate of savings begins six months after delivery of the current system, allowing for time to develop and implement.

Transfer of Learning Assessment

Reigeluth and Scwartz refer to "near" transfer and "far" transfer of learning. Near transfer means that the tasks learned can only be applied to the same tasks with the actual equipment. Far transfer means that the learner is able to apply knowledge to a variety of tasks on the actual equipment not covered specifically in the training. By definition, a job aid should guarantee a very high degree of near transfer of learning. Job aids were recommended by Broad (1982) as a strategy to improve transfer after training has occurred. The issue, in this case, is whether the combination of training and the job aid enable near transfer only, or they enable far transfer as well. The designers did not have time or budget to evaluate this aspect of the training. If future considerations permit, a test of far transfer could be to observe a user performing enabling objective 3.3.3, Find 3rd Aperture Center, as described in Appendix B. That procedure is similar enough to be applicable, but different enough to require some thought, or analysis, by the learner. If a learner completed the training module and then was able to find the 3rd aperture center, then far transfer surely had taken place.

Summary

The designers implemented the assessment and evaluation plans that were made during the Design phase. A technical evaluation was done early in the development phase. A formative evaluation was conducted in two steps, a series of one-on-one evaluations and a field trial, to refine the job aid to a point where it was ready for implementation. Upon implementation, a summative evaluation was conducted to quantify the results of the project and its impact on the organizations involved.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

Introduction

During the course of this project, the designers and their organization, Grumman Simulation/Trainer Products experienced a tremendous growth in the ability to develop interactive computer-based training. This chapter summarizes the development process that the designers undertook. Several conclusions that the designers made, based on their experience, are given. Also included are several important recommendations by the designers. These are generic recommendations that could be of benefit to anyone developing computer-based instruction.

Methods and Procedures Used

Since one goal of Simulation/Trainer Products is to develop training for military customers, the Interservice Procedures for Instructional Systems Development developed at Florida State University (1983) as implemented by the U.S. Army in TRADOC Pamphlet 350-30 "Interservice Procedures for Instructional Systems Development" were followed throughout. The interservice procedures are a systematic approach to the development of training programs. It is a five-phase process that will, if adhered to, lead to educationally effective, cost efficient training. Similarly, the job performance aid was developed in accordance with the U.S. Air Force Human Resource Labs' Technical Report 73-43, "Fully Proceduralized Job Performance Aids; Handbook for JPA Developers." The delivery media was developed in accordance with the U.S. Army TRADOC Circular 351-88-1 "Interactive Courseware (ICW) Management and Development." What occurred during each of the phases of development are described briefly below.

Analysis

The analysis phase encompassed the assessment of the organizational requirement for training. Why did the e-beam systems group come to us for a training system? What is it that they were trying to do, that they felt training was the answer to? The first part of the analysis phase involved a needs assesment. The designers observed the systems integration team as they worked on the EL-3+ system. Extensive interviews were conducted with all levels of the e-beam systems engineering staff; systems engineer through Director of E-Beam Systems. A comprehensive list of the tasks performed by the systems integration engineers was made. This list was reviewed by job incumbents and modified as required. It became apparent to the designers that training was only part of the solution. A large part of the problem could be solved with the development of job aids. Criteria were adopted for deciding which of these tasks were appropriate for training and which were appropriate for a job aid. Similar to a media selection model, the training/job aid selection model yielded a list of tasks appropriate for the job aid and a list of tasks appropriate for training. From the tasks selected for training, one was selected to be fully developed as an interactive training demonstration for IBM.

Design

Job performance measures were established for every task, defining the conditions, behavior and criteria for performance. The appropriate instructional setting for each task was determined. Entry skills, or prerequisite knowledge, was described. The sequence and structure of the tasks to be learned were established. A media analysis was conducted and the instructional delivery method was specified as computer-based, interactive videodisc. The learning activities were specified based on both cognitive and behavioral psychology. A script, consisting of storyboards and flowcharts was created. A plan for assessing the ability of the system to enable mastery of the objectives and transfer that knowledge to the actual equipment was made. Similarly, a plan to evaluate the results of this program was made.

Development

The delivery hardware was procured, assembled and tested. The authoring system was procured, integrated with the hardware and the designers learned how to use it. The job aid and training module were developed in accordance with the script. Videotaping was done at the e-beam systems lab and graphics were made by the S/TP artist. The master tape for the videodisc was edited at the S/TP Audio-Video Lab. The courseware was programmed in parallel to the video production effort. A preliminary version of the instructional materials were set up and a formative evaluation was conducted. The job aid and training module were modified as required for final delivery.

Implementation

A final version of the job aid and training module were delivered to the Grumman E-Beam Systems group. Included with the system was a users' guide to operation. Material was distributed to gather data about the program and directions were included for handling any errors discovered in the system. At the time of this writing, actual implementation had not yet been initiated.

Evaluation

The evaluation process actually began at the start of the project and continued throughout, extending for the duration of its implementation. Every aspect of the project was continually evaluated and modified as necessary. Two formal evaluation phases were conducted. The first was the formative evaluation done during the development phase to determine if the job aid and training module met the learning objectives. The second was the summative evaluation, conducted after the final delivery of the system. The summative evaluation determines whether the program met the goals that the organization had set. An attempt to quantify the impact on the "bottom line" of the organizations was also made at this time. The transfer of training from the learning environment to the working environment was also assessed.

Conclusions

This project was the first time that the designers used the IBM InfoWindow Presentation System hardware and software. Customarily, in a situation such as this, there should have been a greater emphasis on being experimentally-oriented instead of productivity-oriented (Larsen, 1989). Perhaps a smaller initial research and development effort, followed by a true production effort would have been smoother. Never-the-less, a great deal of experience was gained by the designers and their management. Three conclusions based on the experiences of the designers can be made:

1. The simulation that was designed was not possible to develop with the IWPS system. This may be due to a lack of expertise by the developer. The IWPS Editor is a powerful system and the designers do not pretend to be experts. At this level of effort though, it was not possible to develop the simulation as planned. Although, there is no data to support them, the designers do not feel that the educational capabilities of the system were compromised because of this. The designers are confident that any future versions of this training module could incorporate the simulation as planned.

2. The entire project was completed behind schedule, but remained under budget for the duration. The schedule slip was directly attributable to the delay in delivery of the IWPS hardware. Good management practices kept the delays from impacting the budget. The project manager, Jim Becker, deserves accolades for a job well done.

3. The next IVD/CBT-based job, whether for Grumman, IBM or the military will be bid more accurately and performed more efficiently due to the experience gained.

Recommendations

It has been said many times but it is worth repeating again, experience is the best teacher. The designers learned a great deal during the course of this project. As is the case for most training developers, much was learned about the subject matter, the EL-3 electron beam lithography device, that was interesting, but not particularly useful. Much was learned about the use of the IBM InfoWindow Presentation System and this is certainly useful knowledge. But many lessons were learned that the designers feel should be passed to other designers so that they can benefit from the experiences encountered here.

1. If you are going to use a specific product or media to develop your training, be certain of its capabilities before starting your design. This can be done by arranging demonstrations by vendors or the manufacturer. A supplier should also be willing to put you in touch with a current user who will, more than likely, give you an honest appraisal of the product. If a specific question comes up concerning capabilities, do not assume anything, get precise answers from the supplier. Don't feel like you're bothering them, it's their job to keep the customer satisfied.

2. Identify any process or piece of equipment that may constitute what is called a "single-point failure" or a "show-stopper." This could be anything that has no alternative or back-up should a problem arise. In the case of this project, the entire schedule relied on the timely delivery of the IWPS hardware and software. Not having the IWPS display was the proverbial "show-stopper." Arrange with suppliers in advance to borrow equipment if a promised delivery date can't be met. This

concept also applies to personnel as well. If one person on a project is relied on too heavily as either an **SME** or a programmer, etc., the whole project can be stopped by a simple vacation.

3. Always keep in mind that someone may have to pick up your product two years later to make changes to it. Thoroughly document your work and more importantly, design into it features that make it easily maintainable. It is easy to shrug this aspect off and say "what do I care?" But a smart customer will look for maintainability in a product and it may make the difference between having a job or not. The earlier in the development cycle that maintainability features are addressed, the more time and aggravation you will save.

Concluding Statement

It is rare indeed, in this world of departmentalization, to have the opportunity to participate in every phase of a project. The designers of this project had that opportunity and will forever be wiser because of it. At times, the technical nature of the material was positively intimidating and the total responsibility seemed overwhelming. Only a measured, systematic approach to such an endeavor would lead to success. The confidence that the designers now have in the instructional systems development process as a methodology, will enable them to take on any project that may be in store for them in the future.

APPENDIX A

SAMPLE STORYBOARDS FOR ANALYSIS

PROJECT: IBM EL-3

DATE ____________ MODULE __________ EVENT ______

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU

ABEKAS #: ________________ CHYRON #: ________________

Graphic Title: ________________ Disk: ________________

SOURCE SMPTE: ___:___:___:__ DURATION: ___:___:___

MASTER SMPTE: ___:___:___:__ DURATION: ___:___:___

NARRATION ☐ CH.1 ☐ CH.2

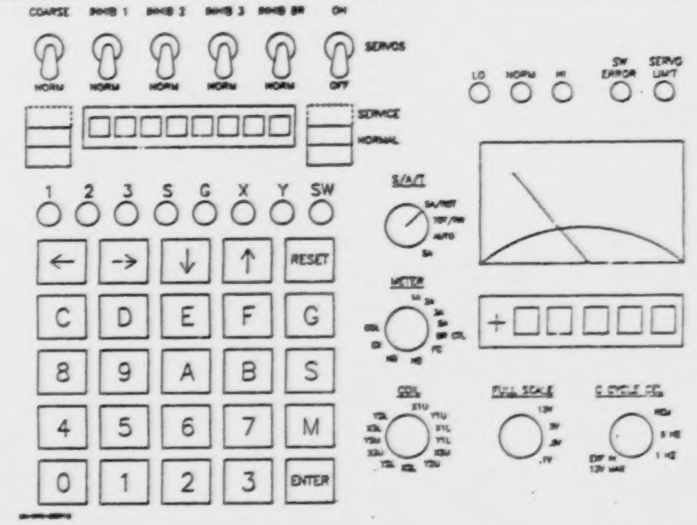
SOURCE SMPTE: ___:___:___:___ DURATION: ___:___:___

COMPUTER OVERLAY

127

VIDEO

1
2
3
4
5
6
7
8
9
10
11
12
13
14


COARSE
INHIB 1
INHIB 2
INHIB 3
INHIB BR
ON
SERVOS
NORM
OFF
LO
NORM
HI
SW ERROR
SERVO LIMIT
SERVICE
NORMAL
1
2
3
S
G
X
Y
SW
←
→
↓
↑
RESET
C
D
E
F
G
8
9
A
B
S
4
5
6
7
M
0
1
2
3
ENTER
METER
FULL SCALE
+

128

PROJEC : IBM EL-3 DATE ________ MODULE ________ E NT ____

PROGRAMMING NOTES: SPOT SHAPE MONITOR

ABEKAS #: ________ CHYRON #: ________

Graphic Title: ________ Disk: ________

SOURCE SMPTE: ___:___:___:__ DURATION: ___:___:___

MASTER SMPTE: ___:___:___:__ DURATION: ___:___:___

NARRATION ☐ CH.1 ☐ CH.2

SOURCE SMPTE: ___:___:___:___ DURATION: ___:___:___

COMPUTER OVERLAY

VIDEO

1
2
3
4
5
6
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8
9
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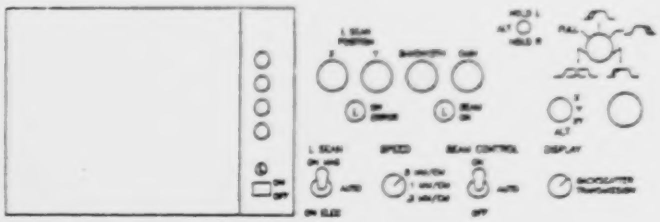
12
13
14


L SCAN POSITION
X
Y
BANDWIDTH
GAIN
HOLD L
ALT
HOLD R
FULL
L SCAN
SPEED
BEAM CONTROL
DISPLAY
ON
AUTO
OFF
ALT
BACKSCATTER
TRANSMISSION

APPENDIX B

STEP LIST FOR TERMINAL LEARNING OBJECTIVE 3.0

The specific behavior, conditions and standards for each task constitute the step list. Items 1.0 and 2.0 list the conditions that must exist in order to use the job aid. Any changes in conditions are given in the step list (3.0). Wherever appropriate, the response expected on the Alignment Brightness FRU Keypad Display is given in parenthesis.

INITIAL CONDITIONS AND SYSTEM POWER-UP

1.0 General Conditions of the E-Beam System.

- o All FRUs functional.
- o Proper vacuum.
- o XY Table operational.
- o System power on.
- o Yoke drivers OFF.

2.0 Initial Conditions and System Power-Up

2.1 Set up Spot Shape Monitor (SSM).

2.1.1 Set BEAM CONTROL switch to ON

2.1.2 Set L SCAN switch to ON ELEC

2.1.3 Turn DISPLAY switch to TRANSMISSION

2.1.4 Turn Shape Switch to XY

2.1.5 Turn SPEED switch adjustment to 5 uM/CM

2.2 Set up Alignment Brightness FRU (ABF).

2.2.1 Turn C CYCLE SEL adjustment to 5 HZ

2.2.2 All Servos NORM or OFF

2.3 Position X-Y table

2.3.1 On MSC terminal type "XMV M XWIRES"

2.3.2 Depress "ENTER"

2.4 Power-Up System

2.4.1 On High-Voltage Controller, press Heater button.

2.4.1 On High-Voltage Controller, press HV button

Module 3

BEAM ALIGNMENT PROCEDURE

****
******   Align 1st Aperture   ******
****

3.1 Align 1st Aperture.

3.1.1 Monitor 2nd Aperture.

3.2.1.1 On ABF, Set S/A/T Switch to TGT/RST position.
3.2.1.2 On ABF, Set Meter Select Switch to 2A.

3.1.2 Set 2ND ALIGNMENT to one side of the aperture.

3.1.2.1 Depress "RESET" button (CMD)
3.1.2.2 Depress "5" (CMD 05)
3.1.2.3 Depress "ENTER" (AL NUM)
3.1.2.4 Depress "2" (X***Y***)
3.1.2.5 Use right arrow key to obtain maximum current reading on DVM (+/- 0.002 mA).

3.1.3 Maximize DVM reading for 2nd Aperture by adjusting 1st alignment.

3.1.3.1 Depress "ENTER" (AL NUM)
3.1.3.2 Depress "1" (X***Y***)
3.1.3.3 Maximize DVM reading (+/- 0.002 mA) with horizontal (left & right) and vertical (up & down) arrow keys.

****
******   Align 2nd Aperture   ******
****

3.2 Align 2nd Aperture.

3.2.1 Monitor 2nd Aperture.

3.2.1.1 On ABF, Set S/A/T Switch to TGT/RST position.
3.2.1.2 On ABF, Set Meter Select Switch to 2A.

3.2.2 Center the Beam in the 2nd Aperture.

3.2.2.1 Depress "ENTER" (AL NUM)
3.2.2.2 Depress "2" (X***Y***)
3.2.2.3 Depress Left Arrow key to minimize DVM reading.
3.2.2.4 Minimize DVM reading (+/- 0.002 mA) with horizontal (left & right) and vertical (up & down) arrow keys.

****
******   Align 3rd Aperture   ******
****

3.3 Align 3rd Aperture

3.3.1 Monitor 3rd Aperture.

3.3.1.1 On ABF, Set S/A/T Switch to TGT/RST position.
3.3.1.2 On ABF, Set Meter Select Switch to 3A.

3.3.2 Center Beam in the 3rd Aperture.

3.3.2.1	Depress "ENTER"	(AL NUM)
3.3.2.4	Depress "C" for coarse adjustment.	(3 OR S)
3.3.2.5	Depress "3"	(X***Y***)
3.4.2.6	Depress "1 - F" to select Rate of coarse change.	(X***Y***)
3.4.2.7	Use horizontal (left & right) and vertical (up & down) arrow keys to find coarse center: Minimize DVM current reading (+/- 0.10 mA).	
3.4.2.8	Depress "Enter"	(AL NUM)
3.4.2.9	Depress "3"	(X***Y***)
3.4.2.10	Minimize DVM reading (+/- 0.002 mA) with horizontal (left & right) and vertical (up & down) arrow keys.	

3.3.3 If the DVM reading does not change, the beam is not passing through the 3rd Aperture Center.

Dither X & Y to find the 3rd Aperture.
Steps 3.3.3.1 - 3.3.3.2

Otherwise, continue with Step 3.3.4

3.3.3.1 Dither Y

3.3.3.1.1	Depress "RESET"	(CMD)
3.3.3.1.2	Depress "3"	(CMD 03)
3.3.3.1.3	Depress "ENTER"	(DITH 3 C)
3.3.3.1.4	Depress "ENTER"	(X/0 Y/1)
3.3.3.1.5	Depress "0"	(X***Y***)
3.3.3.1.6	Use horizontal arrow keys to move beam in Y axis until "spike" is seen on SSM.	

3.3.3.2 Dither X

3.3.3.2.1	Depress "ENTER"	(DITH 3 C)
3.3.3.2.2	Depress "ENTER"	(X/0 Y/1)
3.3.3.2.3	Type "1"	(X***Y***)
3.3.3.2.4	Use horizontal arrow keys to move beam in X axis until "spike" is seen on SSM.	

3.3.3.3 Repeat From Step 3.3; Align 3rd Aperture.

****

******   Align Sample Aperture   ******

****

3.4 Align Sample Aperture

3.4.1 Monitor SAMPLE Aperture

3.4.1.1 On ABF, Set S/A/T switch to SA/RST position.
3.4.1.2 On ABF, Set Meter Select Switch to SA.

3.4.2 Maximize SA current on DVM

3.4.2.3 Depress "ENTER" (AL NUM)
3.4.2.4 Depress "C" for coarse adjustment. (3 OR S)
3.4.2.5 Depress "S" (X***Y***)
3.4.2.6 Depress "1 - F" to select Rate of coarse change. (X***Y***)
3.4.2.7 Use horizontal (left & right) and vertical (up & down) arrow keys to find coarse center: Maximize DVM current reading (+/- 0.10 mA).
3.4.2.8 Depress "Enter" (AL NUM)
3.4.2.9 Depress "S" (X***Y***)
3.4.2.10 Maximize DVM reading (+/- 0.002 mA) with horizontal (left & right) and vertical (up & down) arrow keys.

3.4.3 Align 3rd Aperture

3.4.3.1 Monitor 3rd Aperture.

3.4.3.1.1 Set S/A/T Switch to TGT/RST position.
3.4.3.1.2 Set Meter Select Switch to 3A.

3.4.3.2 Center Beam in the 3rd Aperture.

3.4.3.2.1 Depress "ENTER" (AL NUM)
3.4.3.2.2 Depress "C" for coarse adjustment. (3 OR S)
3.4.3.2.3 Depress "3" (X***Y***)
3.4.3.2.4 Depress "1 - F" to select Rate of change. (X***Y***)
3.4.3.2.5 Use horizontal (left & right) and vertical (up & down) arrow keys to find coarse center: Minimize DVM current reading (+/- 0.10 mA).
3.4.3.2.6 Depress "Enter" (AL NUM)
3.4.3.2.7 Depress "3" (X***Y***)
3.4.3.2.8 Use horizontal (left & right) and vertical (up & down) arrow keys to minimize DVM current reading (+/- 0.10 mA).

****

****** Check Filament Profile ******

****

3.5 Check filament profile.

3.5.1 Monitor 2nd Aperture.

3.5.1.1 On ABF, Set S/A/T Switch to TGT/RST position.
3.5.1.2 On ABF, Set Meter Select Switch to 2A.

3.5.2 Check Switch Settings on Spot Shape Monitor.

3.5.2.1 Set Beam Control to ON.
3.5.2.2 Set L Scan to ON ELEC.
3.5.2.3 Set Display switch to TRANSMISSION.

3.5.3 Use Alignment Brightness FRU to get Filament Profile.

3.5.3.1 Depress "RESET" (CMD)
3.5.3.2 Depress "4" (CMD 04)
3.5.3.3 Depress "ENTER" (EM PROF)
3.5.3.4 Depress "ENTER" (X***Y***)
"1" and "X" LEDs illuminate.

3.5.4 Observe Waveforms on Spot Shape Monitor (SSM),
Compare to good waveform:

If X Profile is good, go to 3.5.5

If Filament Profile is not correct:

First: 3.6 Align Anode
Second: 3.7 Adjust Heater/Emission Current
Third: 3.8 Replace Filament

3.5.5 Verify Beam Profile for Y.

3.5.5.1 Depress "S" (EM PROF)
3.5.5.1 Depress "0" (X***Y***)
"1" and "Y" LEDs illuminate.

3.5.6 Observe Waveforms:

If X and Y Profile is good, go to 3.9

If Filament Profile is not correct:

3.11 Adjust Heater/Emission Current for both X and Y until they are the same.

```
****************************************************************
******                   Align Anode                      ******
****************************************************************
```

3.6 Align Anode

3.6.1 Monitor 2nd Aperture.

3.6.1.1 On ABF, Set S/A/T Switch to TGT/RST position.
3.6.1.2 On ABF, Set Meter Select Switch to 2A.

3.6.2 Set 2ND ALIGNMENT to one side.

3.6.2.1	Depress "RESET" button	(CMD)
3.6.2.2	Depress "5"	(CMD 05)
3.6.2.3	Depress "ENTER"	(AL NUM)
3.6.2.4	Depress "2"	(X***Y***)
3.6.2.5	Use right arrow key to maximize DVM current reading (+/- 0.10 mA).	

3.6.3 Set 1ST ALIGNMENT X and Y to 800

3.6.3.1	Depress "RESET" button on keypad.	(CMD)
3.6.3.2	Type command "5" on keypad.	(CMD 05)
3.6.3.3	Depress "ENTER"	(AL NUM)
3.6.3.4	Depress "1"	(X***Y***)
3.6.3.5	Use horizontal (left &right) arrow keys to set X alignment to 800	(X800Y***)
3.6.3.6	Use vertical (up & down) arrow keys to set Y alignment to 800	(X800Y800)

3.6.4 Maximize DVM reading (+/- 0.002 mA) on ABF by adjusting Anode Positioning screws on e-gun

3.6.5 Repeat Alignment Steps 3.1 - 3.5

****** Adjust Heater/Emission Current ******

3.7 Adjust heater/emission current

If NOT at the PROFILE procedure, begin at 3.7.1

3.7.1	Depress "RESET"	(CMD)
3.7.2	Depress "4"	(CMD 04)
3.7.3	Depress "ENTER"	(EM PROF)
3.7.4	Depress "ENTER"	(X***Y***)

If already in PROFILE mode, begin at 3.7.5

3.7.5	Depress "ENTER"	(AL NUM)
3.7.6	Depress "G" "G" and "X" LEDs illuminate.	(H***G***)
3.7.7	Use horizontal (left & right) arrow keys to adjust H value for X.	
3.7.8	Use vertical (up & down) arrow keys to adjust G value for X.	
3.7.9	Depress "S"	
3.7.10	Depress "0" "G" and "Y" LEDs illuminate.	(H***G***)
3.7.11	Use horizontal (left & right) arrow keys to adjust H value for Y.	
3.7.12	Use vertical (up & down) arrow keys to adjust G value for Y.	

Replace Filament

3.8 Replace the Filament.

3.8.1 Set 1ST ALIGNMENT X and Y to 800

3.8.1.1 Depress "RESET" button on keypad. (CMD)
3.8.1.2 Type command "5" on keypad. (CMD 05)
3.8.1.3 Depress "ENTER" (AL NUM)
3.8.1.4 Depress "1" (X***Y***)
3.8.1.5 Use horizontal (left &right) arrow keys to set X alignment to 800 (X800Y***)
3.8.1.6 Use vertical (up & down) arrow keys to set Y alignment to 800 (X800Y800)

3.8.2 Set 2ND ALIGNMENT to one side.

3.8.2.1 Monitor 2nd Aperture.

3.8.2.1.1 Set S/A/T Switch to TGT/RST position.
3.8.2.1.2 Set Meter Select Switch to 2A.

3.8.2.2 Maximize DVM reading.

3.8.2.2.1 Depress "ENTER" (AL NUM)
3.8.2.2.2 Depress "2" (X***Y***)
3.8.2.2.3 Use right arrow key to maximize current reading on DVM.

3.8.3 Turn heater/emission current down to 0

3.8.3.1 On ABF depress "RESET" (CMD)
3.8.3.2 On ABF depress "5" (CMD 05)
3.8.3.3 On ABF depress "ENTER" (AL NUM)
3.8.3.4 On ABF depress "G" (H***G***)
3.8.3.5 Record G value.
3.8.3.6 Use left arrow key to reduce H value to 0. (H000G***) Current indication on HV Controller will decrease to 0.
3.8.3.7 Use down arrow key to reduce G value to 0. (H000G000) Current indication on HV Controller will decrease to 0.

3.8.4 Set Mode switch on HV Controller to "1.5 kV" position to "Pinch" the beam.

3.8.5 Depress filament Turret Rotation Switch on filament ball.

3.8.6 Set Mode switch on HV Controller to "0-2 mA" position to "Un-Pinch" the beam.

3.8.7 Set heater and emission current.

- 3.8.7.1 On ABF depress "RESET" (CMD)
- 3.8.7.2 On ABF depress "5" (CMD 05)
- 3.8.7.3 On ABF depress "ENTER" (AL NUM)
- 3.8.7.4 On ABF depress "G" (H***G***)
- 3.8.7.5 Use right arrow key to increase current reading on HV Controller to approximately 1.0 A.
- 3.8.7.6 Use up arrow key to set G value on ABF display to 100 [hex] (H***Y100)

3.8.8 Repeat Alignment Steps 3.1 - 3.5

****
****** Check Faraday Cup ******
****

3.9 Check Faraday Cup

3.9.1 Monitor Faraday Cup.

- 3.9.1.1 Set S/A/T Switch to TGT/RST position.
- 3.9.1.2 Set Meter Select Switch to FC.

3.9.2 Make Sure SERVO switch on ABF to OFF.

3.9.3 Position X-Y Table to Faraday Cup.

- 3.9.3.1 At MSC Terminal; Type "XMV M FCUP"
- 3.9.3.2 At MSC Terminal; Depress "ENTER"

3.9.4 Check DVM on ABF for (System spec. [4.0uA]) reading

3.9.5 If DVM reading not (System spec. [4.0 uA]) increase or decrease beam current as needed.

- 3.9.5.1 Depress "RESET" (CMD)
- 3.9.5.2 Depress "5" (CMD 05)
- 3.9.5.3 Depress "ENTER" (AL NUM)
- 3.9.5.4 Depress "G" (H***G***)
- 3.9.5.5 Use up or down arrow keys to obtain (System Spec) reading on DVM.

****
******   Check Target Adjustment   ******
****

3.10 Check Target Adjustment.

3.10.1 Set S/A/T Switch to AUTO
3.10.2 Turn SERVO switch on ABF to ON.
3.10.3 Allow 1/2 hour for warm up.
3.10.4 Green LED (Normal) should be illuminated.
3.10.5 If Normal LED is illuminated, but DVM does not indicate (System Spec.), perform Step 3.8

3.11 Adjust Target Setting.

3.11.1 Monitor Target.

3.11.1.1 Set S/A/T Switch to AUTO position.
3.11.1.2 Set Meter Select Switch to BR.

3.11.2 Turn Servos off

3.11.1.1 INHIB 1
3.11.1.2 INHIB 2
3.11.1.3 INHIB 3
3.11.1.4 INHIB BR

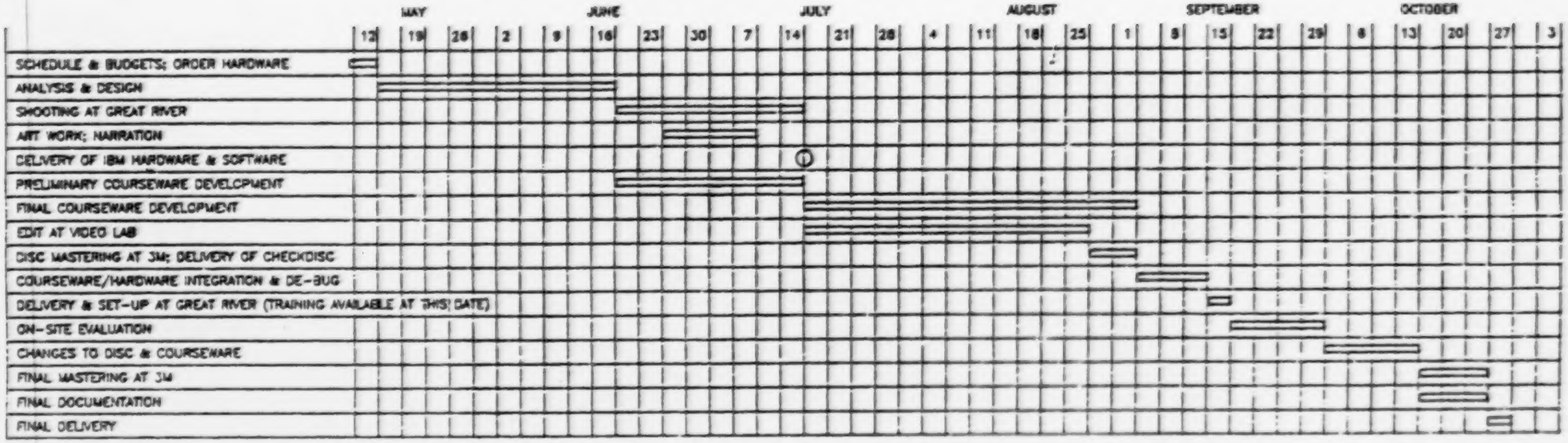
3.11.3 Adjust Target Pot for Servo LED at Normal (Green) when DVM reading equals reading at Faraday Cup.

APPENDIX C

SCHEDULES

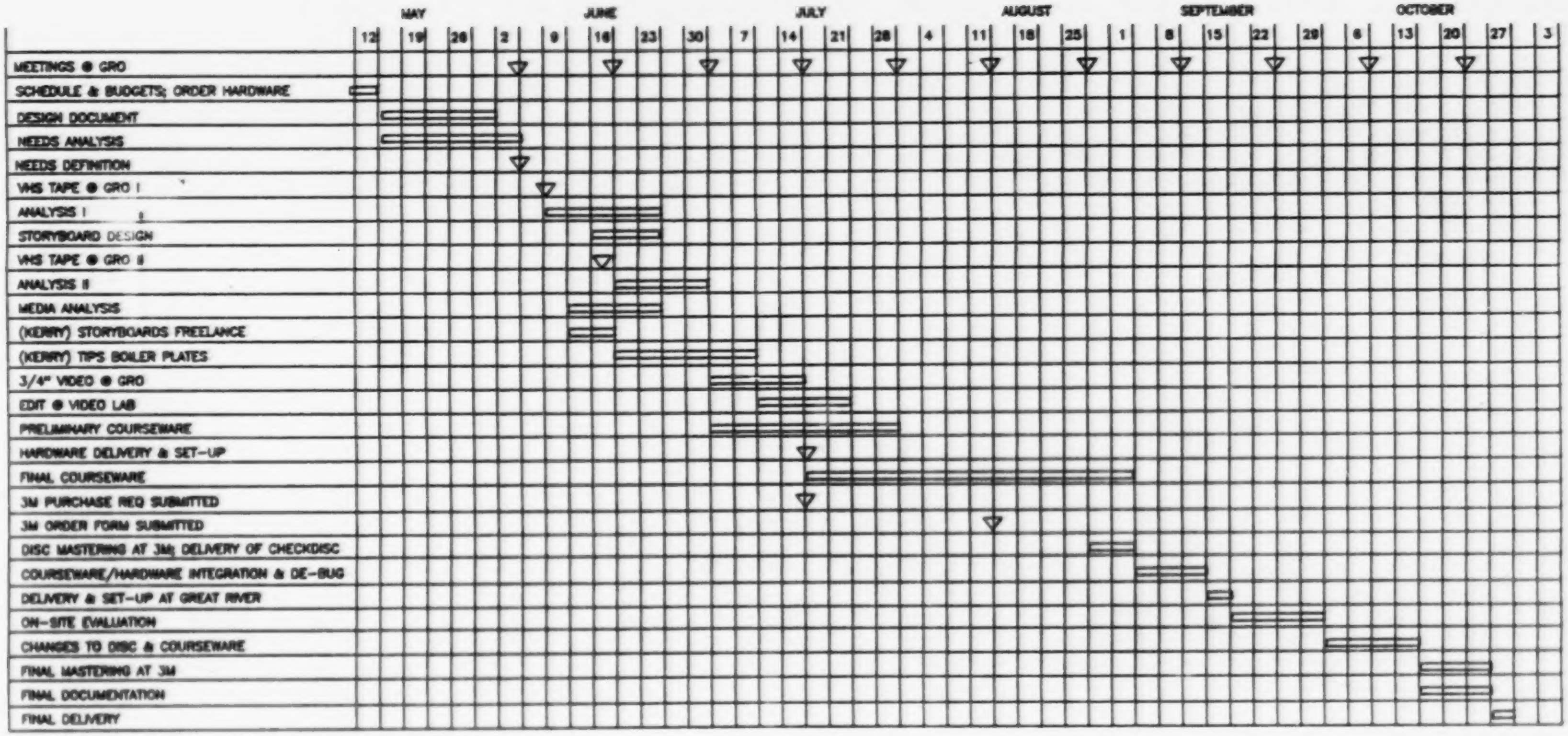
IBM EL-3+

VER 2.0
5 JUNE 89



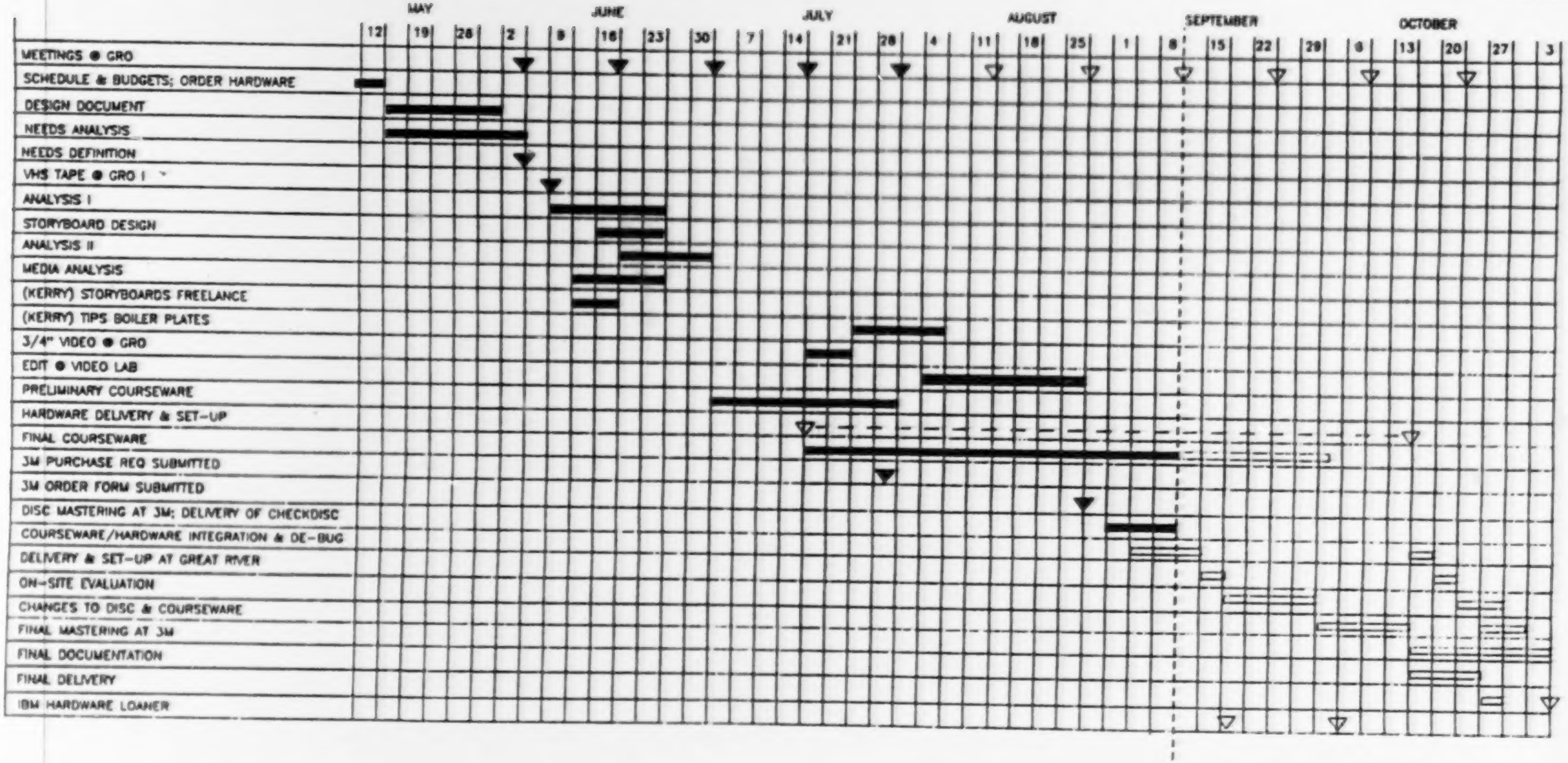
IBM EL-3+

VER 4.0
19 JUNE 89



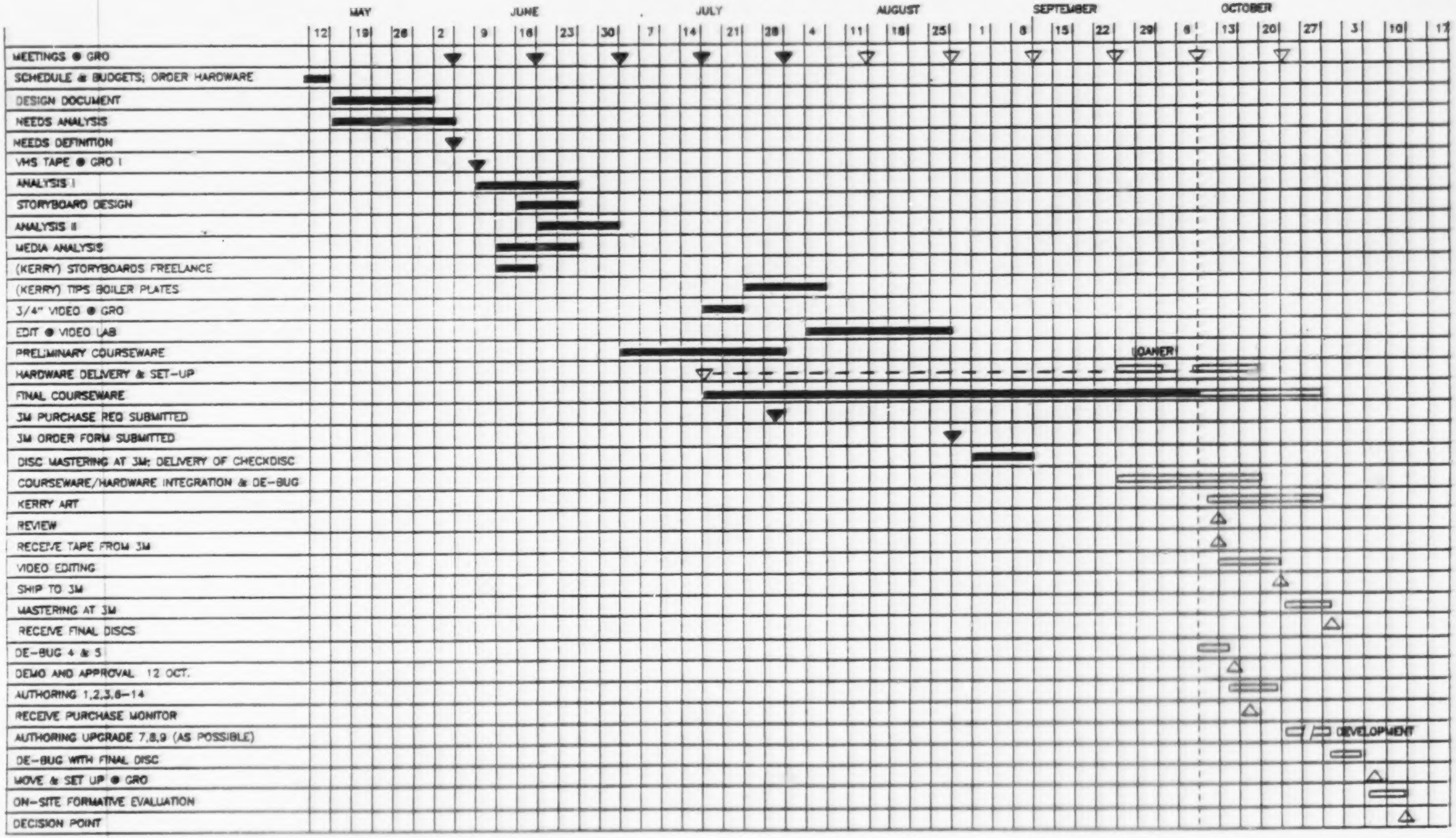
IBM EL-3+

VER 8.0
12 SEPT. 89



IBM EL-3+

VER 7.0
6 OCT. 89



KA-6V3-08813

APPENDIX D

BUDGET DOCUMENTATION

To: Winston Thaw
From: Bob Von Der Linn
Date: 10 May 89

Subject: Hardware and Software Requirements for EL-3+ Training

Two complete systems will be needed to implement the training.

The first system will be a development workstation to be located at Display/Trainer Products (Pl. 47). This hardware and software must be available to D/TP no later than 19 June 89 in order to meet our schedule.

The second system will be the deliverable workstation that will be located at Great River (Pl.43). That system must be available by 15 September 89.

This is a complete list of the hardware and software required for the EL-3+ Training systems, both development and deliverable. Also included is a recent quoted price for each component as well as the appropriate part number.

The following items will be needed for both the deliverable training systems and the development system at Display/Trainer Products:

1) PS/2 Model 30 (640K, 20MB)	8530-021	2395.00
2) InfoWindow EGA card	5240	757.00
3) GPIB Adapter card	1503	309.00
4) EGA Jumper card	6583	41.00
5) GPIB cable	5040	106.00
6) InfoWindow Display	4055-001	4395.00
7) DOS 4.0 Operating System	6280256	120.00
8) InfoWindow Control Program (V1.3)	587-BBB FC8392	180.00
9) IWPS Interpreter Software	6024505	135.00

The following item will be needed for the development system at Display/Trainer Products only:

10) IWPS Editor Software	6024504	4975.00

The following items will have to be purchased for the deliverable systems. Display/Trainer Products will supply its own videodisc player for development.

11) Sony LDP-1500 Videodisc player	1325.00
12) Sony Adapter Cable	145.00

```
10-18-89        IBM/EL-3 PLUS   10/13-4288-2012-047  on-loan to 43/2443
                starting 31 Jul:10/13-4878-2012-047  on-loan to 43/2443
================================================================================================================================================

ACTUAL  HOURS

                   MAY MAY MAY JUN JUN JUN JUN JUN JUL JUL JUL JUL AUG AUG AUG AUG SEP SEP SEP SEP SEP OCT OCT OCT OCT NOV NOV NOV NOV   TOTAL
                    12  19  26   2   9  16  23  30   7  14  21  28   4  11  18  25   1   8  15  22  29   6  13  20  27   3  10  17  24


R VONDERLINN        18  32 .23   6  34  39  38  36  18  47  39      37  39  12  32  30  12   6  35  32  44  32  36  10  29  27  40         783
K STEVENSON             19  40  28  40  40  36  32  22  44  40  40  32  32  40  40  24  24  44  46  42  45  32  44  43  35  38  36         978
J STONGE                     1   1   2       8   6   1   2           1   5                           2   8   6                              43
K ADAMS                             12  11   1                  24  21  12   4                                      11           5             101
W FRANK                                                                                                  8                                      8
                   ---------------------------------------------------------------------------------------------------------------------------
ACTUAL HOURS        18  51  64  35  88  90  83  74  41  93  79  64  91  88  56  72  54  36  50  83  90  95  64  91  53  64  70  76        1913

================================================================================================================================================

ESTIMATED HOURS

                   MAY MAY MAY JUN JUN JUN JUN JUN JUL JUL JUL JUL AUG AUG AUG AUG SEP SEP SEP SEP SEP OCT OCT OCT OCT NOV NOV NOV NOV   TOTAL
                    12  19  26   2   9  16  23  30   7  14  21  28   4  11  18  25   1   8  15  22  29   6  13  20  27   3  10  17  24


R VONDERLINN        16  40  20  20  40  40  40  40  24  40  40      40  40      40  40  40  40  40  40  40  40  40  40   -   -   -   -     840
K STEVENSON         16  40  40  40  40  40  40  40  24  40  40  40  40  40  40  40  40  40  40  40  40  40  40  40  40   -   -   -   -     960
J STONGE                     8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   8   -   -   -   -     184
K ADAMS                              8  16   8      16   8   8       8       8                                           -   -   -   -      80
W FRANK                                     24  16  16  16   8                                                           -   -   -   -      80
                   ---------------------------------------------------------------------------------------------------------------------------
ESTIMATED HOURS     32  80  68  68  96 104 120 104  88 112 104  48  96  88  56  88  88  88  88  88  88  88  88  88  88   -   -   -   -    2144

================================================================================================================================================

SUMMARY

                   MAY MAY MAY JUN JUN JUN JUN JUN JUL JUL JUL JUL AUG AUG AUG AUG SEP SEP SEP SEP SEP OCT OCT OCT OCT NOV NOV NOV NOV   TOTAL
                    12  19  26   2   9  16  23  30   7  14  21  28   4  11  18  25   1   8  15  22  29   6  13  20  27   3  10  17  24


ESTIMATED           32  80  68  68  96 104 120 104  88 112 104  48  96  88  56  88  88  88  88  88  88  88  88  88  88   -   -   -   -    2144
ACTUALS             18  51  64  35  88  90  83  74  41  93  79  64  91  88  56  72  54  36  50  83  90  95  64  91  53  64  70  76        1913
                   ---------------------------------------------------------------------------------------------------------------------------
WEEKLY BALANCE      14  29   4  33   8  14  37  30  47  19  25 -16   5          16  34  52  38   5  -2  -7  24  -3  35 -64 -70 -76         231

CUM BALANCE         14  43  47  80  88 102 139 169 216 235 260 244 249 249 249 265 299 351 389 394 392 385 409 406 441 377 307 231         231

================================================================================================================================================
```

APPENDIX E

STORYBOARDS FOR DEVELOPMENT

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.0 COL: 3

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809-6812

ABEKAS #: ____________ CHYRON #: ____________

Graphic Title: IBM 1B Disk: ____________

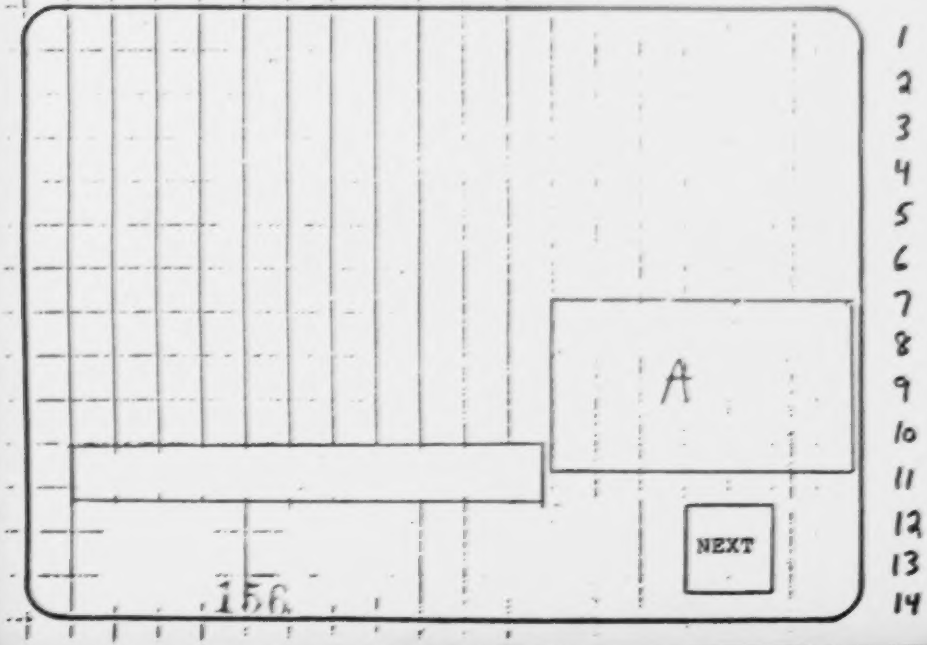
SOURCE SMPTE: ___:___:___:___ DURATION: ___:___:___

MASTER SMPTE: ___:07:46:28 DURATION: ___:00:04

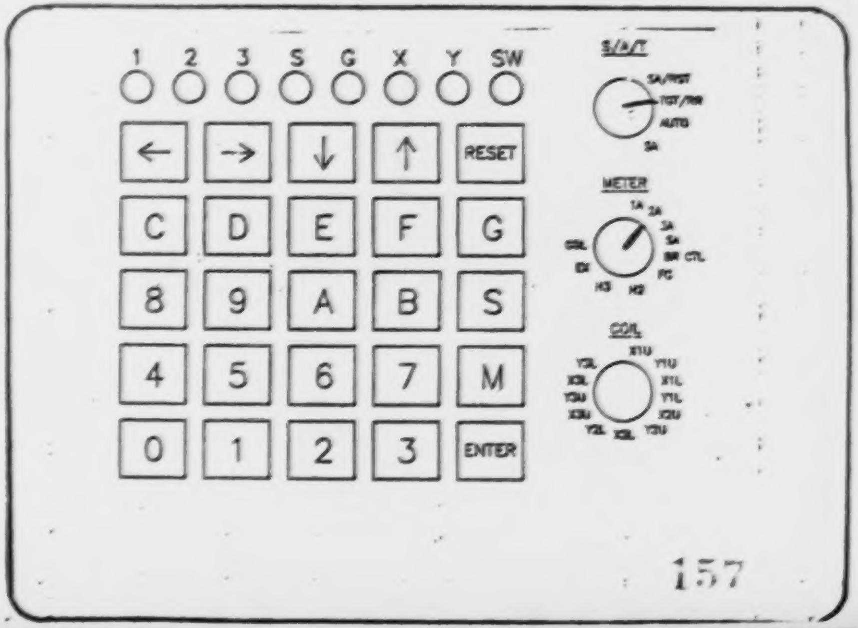
TEXT ☐ ☐

A. IF YOU KNOW WHERE TO START, GO AHEAD. OTHERWISE TOUCH NEXT

COMPUTER OVERLAY


A
NEXT
1
2
3
4
5
6
7
8
9
10
11
12
13
14

VIDEO


1
2
3
S
G
X
Y
SW
←
→
↓
↑
RESET
C
D
E
F
G
8
9
A
B
S
4
5
6
7
M
0
1
2
3
ENTER
S/A/T
METER
COIL

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.1 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

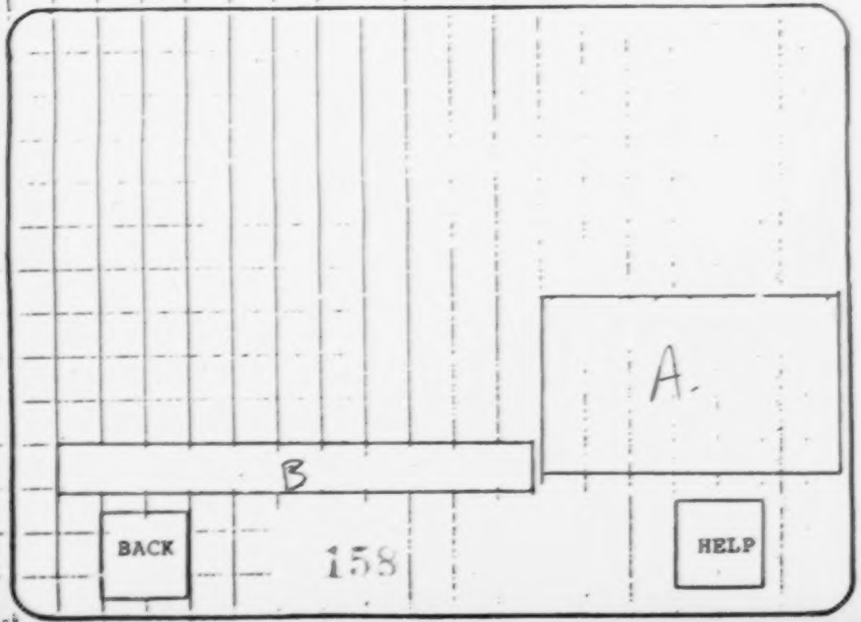
ABEKAS #: CHYRON #:
Graphic Title: IBM 1B Disk:
SOURCE SMPTE: : : : DURATION: : :
MASTER SMPTE: : 07 : 46 : 28 DURATION: : 00 : 04

TEXT ☐ ☐

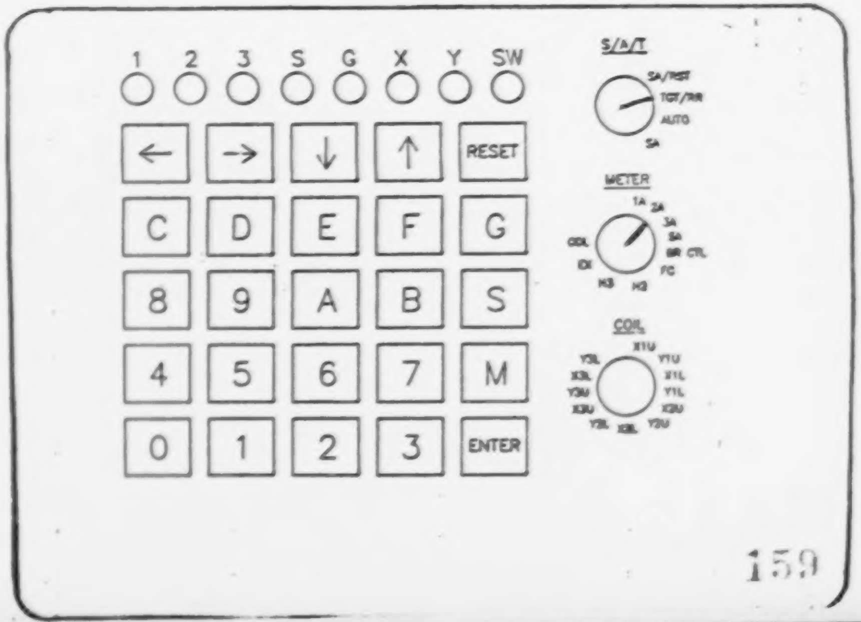
A. HOW DO YOU SELECT THE APERTURE TO MONITOR WITH THE DUM?

B. SET METER SELECT SWITCH TO THE "2A" POSITION.

COMPUTER OVERLAY


A.
B
BACK
158
HELP

VIDEO


1 2 3 S G X Y SW
←
→
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TGT/RR
AUTO
SA
METER
1A
2A
3A
5A
BR CTL
FC
H2
H3
IDI
COL
COIL
X1U
Y1U
X1L
Y1L
X2U
Y2U
X2L
Y2L
X3U
Y3U
X3L
Y3L
159

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.1 COL: REINF

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809-6812

TEXT

☐ ☐

B. EXCELLENT! YOU'RE OFF TO A GREAT START.

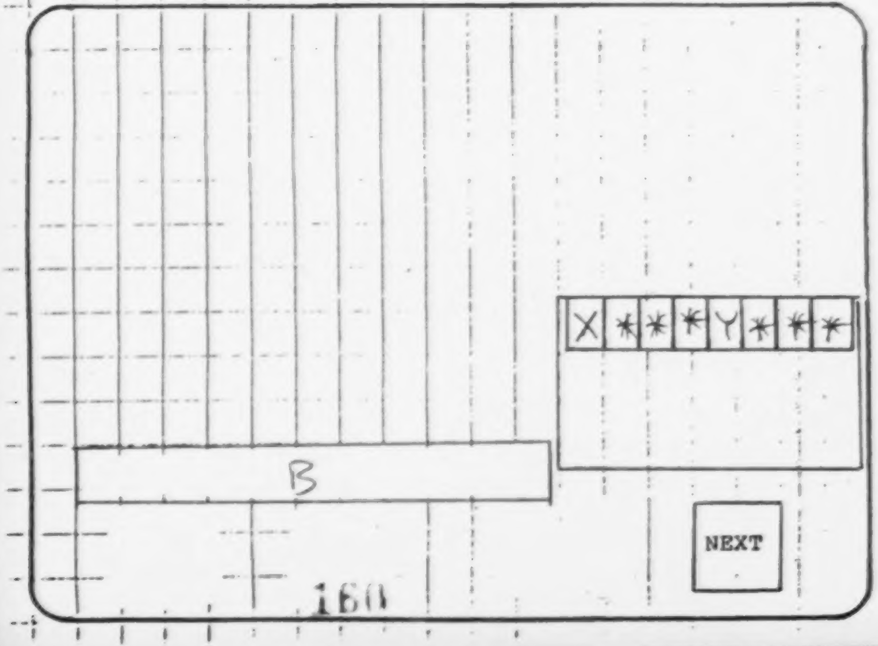
ABEKAS #: ______ CHYRON #: ______

Graphic Title: IBM 1B Disk: ______

SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

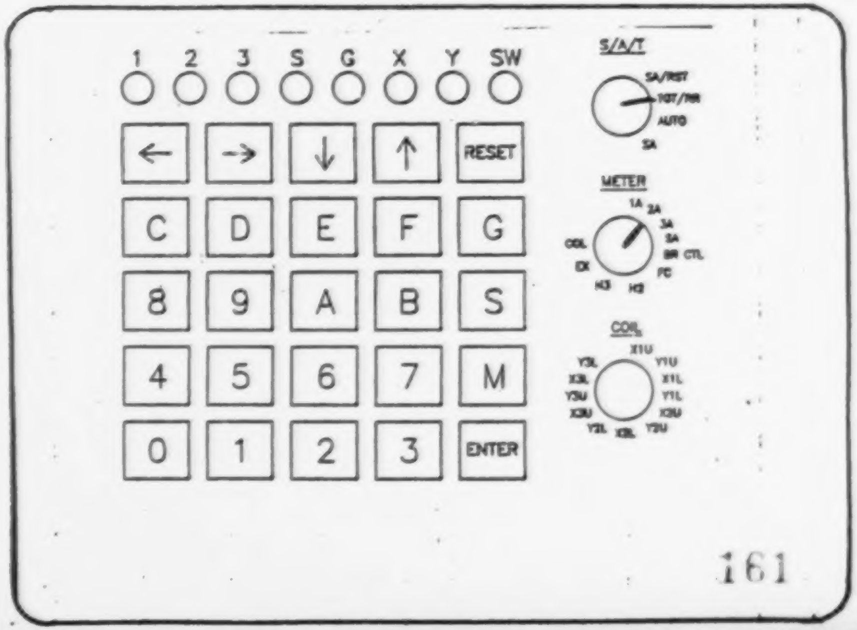
MASTER SMPTE: __:07:46:28 DURATION: __:00:04

COMPUTER OVERLAY



X * * * Y * * *
B
NEXT
160

VIDEO



1 2 3 S G X Y SW
← → ↓ ↑ RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TGT/RR
AUTO
SA
METER
1A 2A 3A 5A BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y2U X2L Y2L X3U Y3U X3L Y3L
161

PROJECT: IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2.1 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ______ CHYRON #: ______
Graphic Title: IBM 1B Disk: ______
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __: 07: 46: 28 DURATION: __: 00: 04

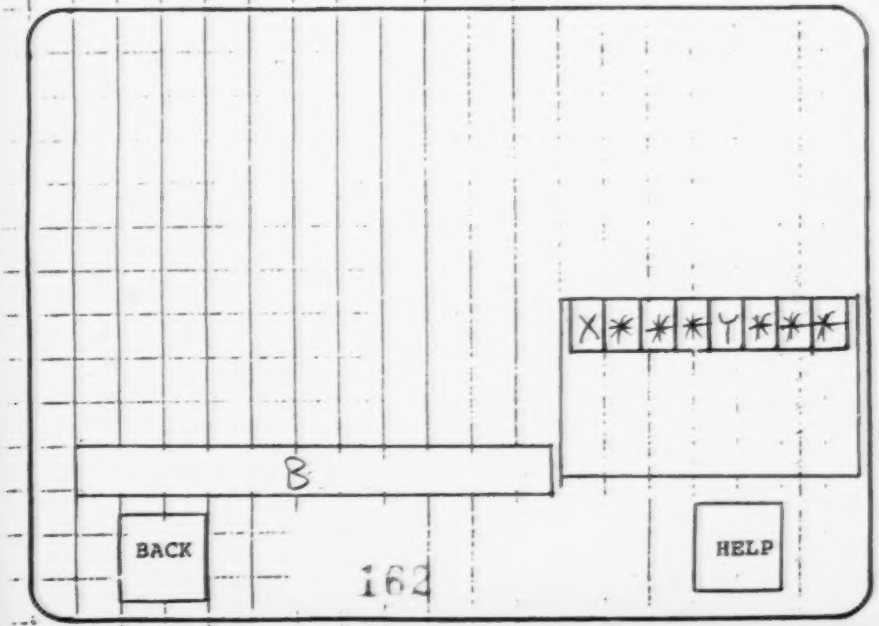
TEXT ☐ ☐ OTHER

B. HOW DO YOU RESET THE ABF FUNCTION KEYPAD?

B. NO, THATS NOT IT, TRY AGAIN.

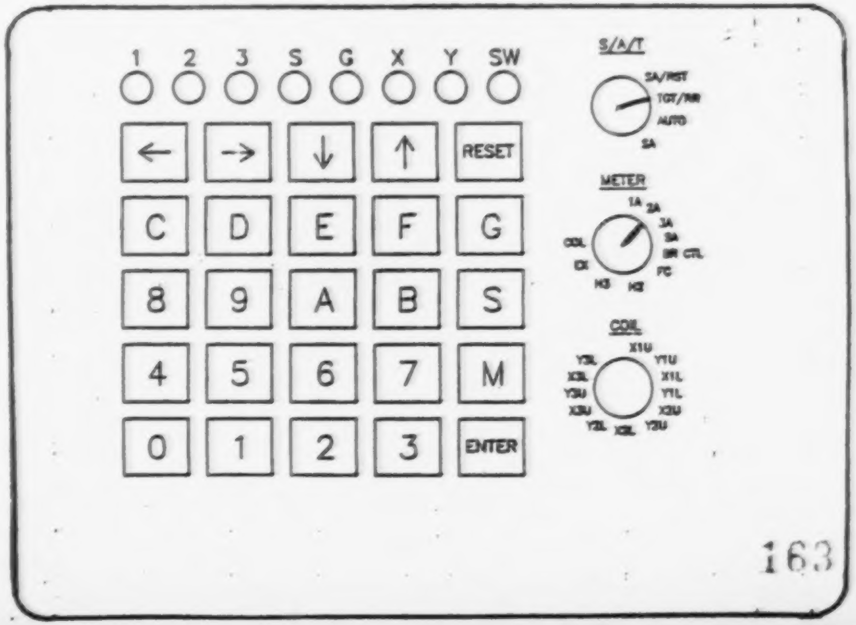
B. TO RESET THE ABF FUNCTION KEYPAD, PRESS THE RESET KEY.

COMPUTER OVERLAY


X * * * Y * * *
B
BACK
HELP

1
2
3
4
5
6
7
8
9
10
11
12
13
14

VIDEO


1 2 3 S G X Y SW
←
→
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TGT/NR
AUTO
SA
METER
1A
2A
3A
SA
BR CTL
FC
H2
H3
CX
COL
COIL
X1U
Y1U
X1L
Y1L
X2U
Y2U
X2L
Y2L
X3U
Y3U
X3L
Y3L

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.2.1 COL: REINF

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809-6812

TEXT ☐ ☐

B. YOU'RE DOING GREAT!

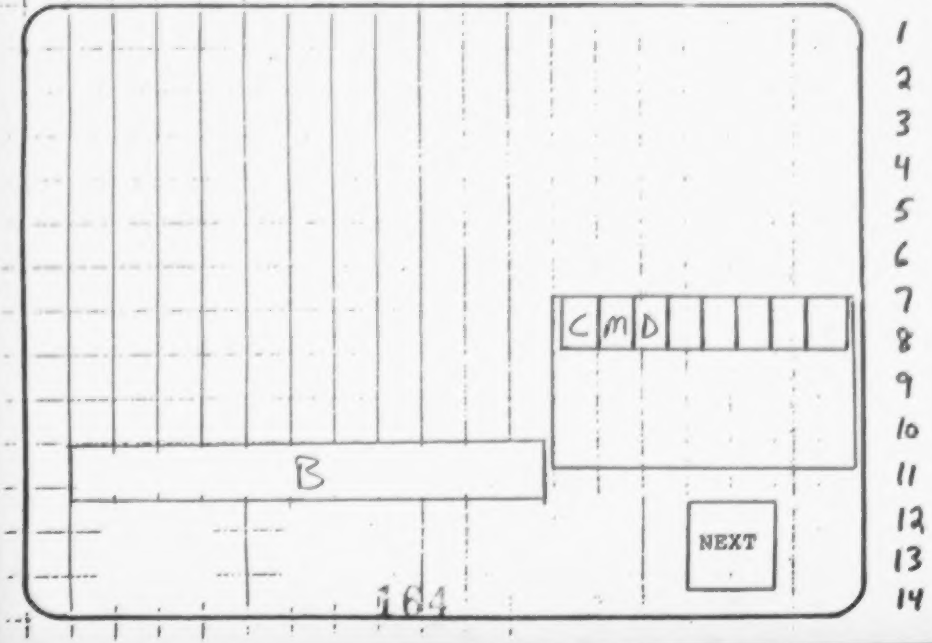
ABEKAS #:________ CHYRON #:________

Graphic Title: IBM 1B Disk:________

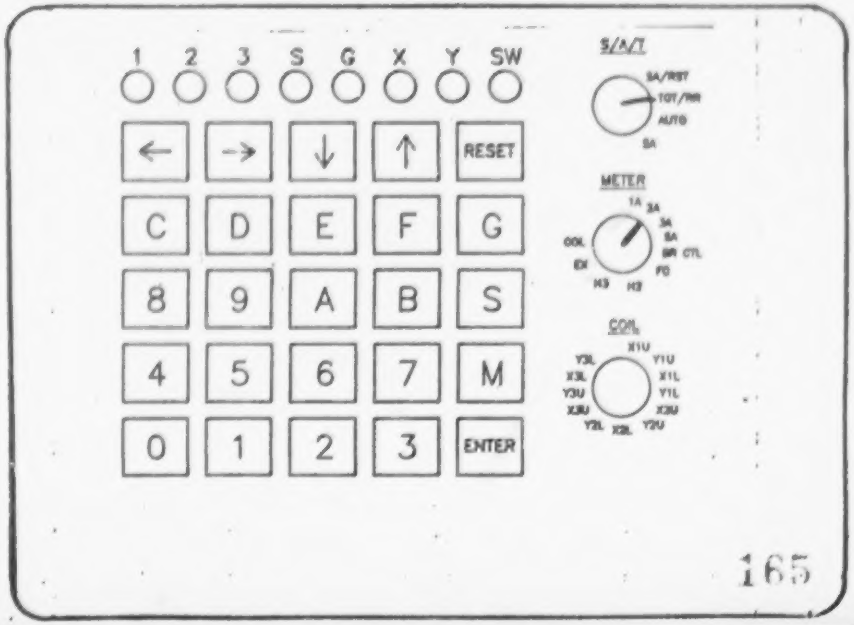
SOURCE SMPTE:___:___:___:___ DURATION:___:___:___

MASTER SMPTE:___:07:46:28 DURATION:___:00:04

COMPUTER OVERLAY


C
M
D
B
NEXT
1
2
3
4
5
6
7
8
9
10
11
12
13
14

VIDEO


1
2
3
S
G
X
Y
SW
←
→
↓
↑
RESET
C
D
E
F
G
8
9
A
B
S
4
5
6
7
M
0
1
2
3
ENTER
S/A/T
SA/RST
TOT/RR
AUTO
SA
METER
COL

PROJECT: IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2.2 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ____ CHYRON #: ____
Graphic Title: IBM 1B Disk: ____
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __: 07: 46: 28 DURATION: __: 00: 04

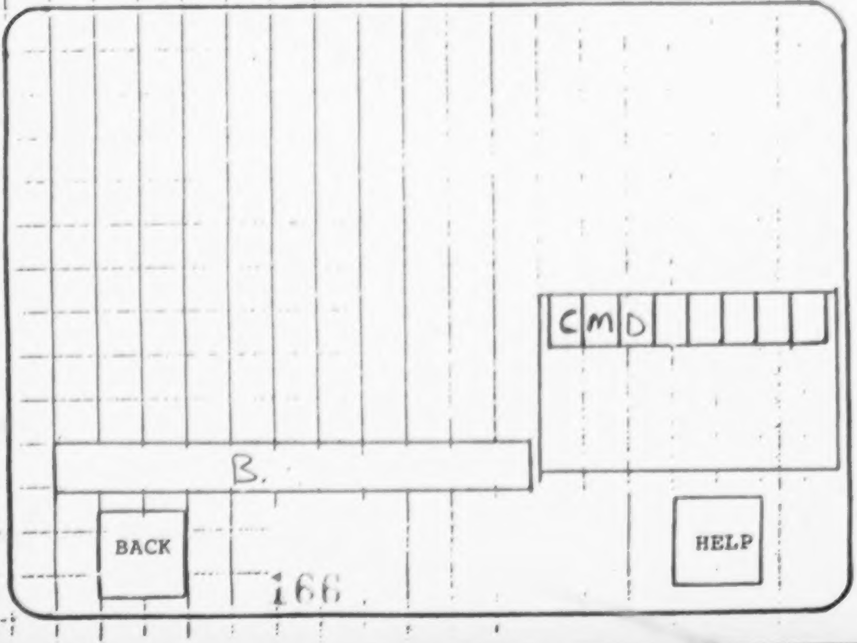
TEXT ☐ ☐ OTHER

B. WHICH COMMAND WILL SELECT THE ALIGNMENT PROCEDURES?

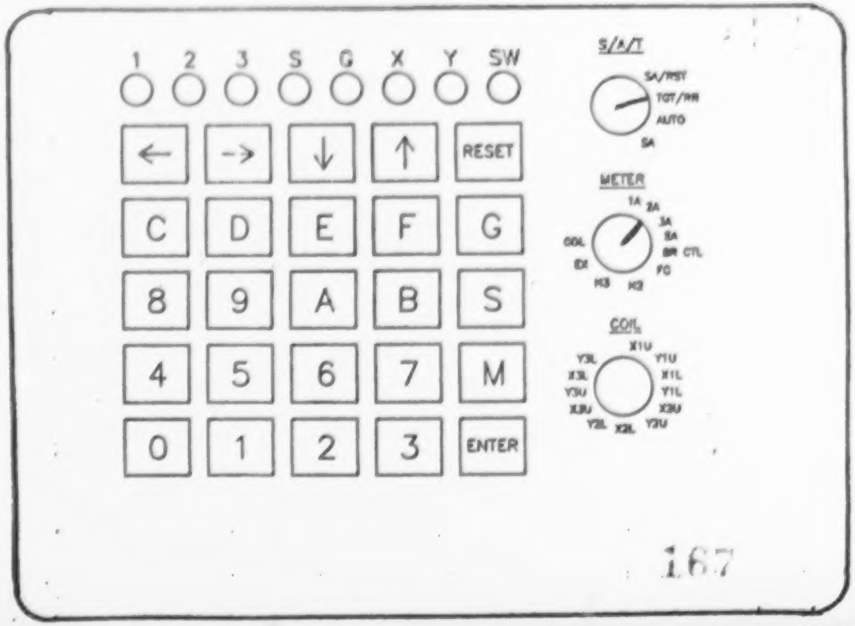
B. COMMAND 5 ACCESSES THE ALIGNMENT PROCEDURES, PRESS THE "5" KEY.

B. NO THATS NOT IT, TRY AGAIN.

COMPUTER OVERLAY


CMD
B.
BACK
HELP

VIDEO


1 2 3 S G X Y SW
←
→
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TGT/RR
AUTO
SA
METER
1A 2A 3A SA BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y2U X2L Y2L X3U Y3U X3L Y3L

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.2.2 COL: REINF

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU

FRAMES: 6809-6812

ABEKAS #: CHYRON #:

Graphic Title: IBM 1B Disk:

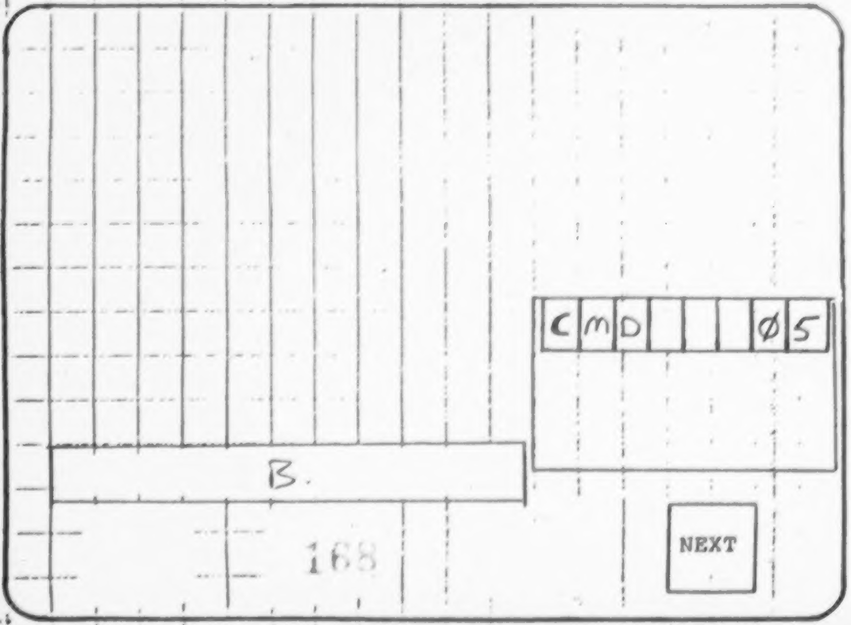
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

MASTER SMPTE: __:07:46:28 DURATION: __:00:04

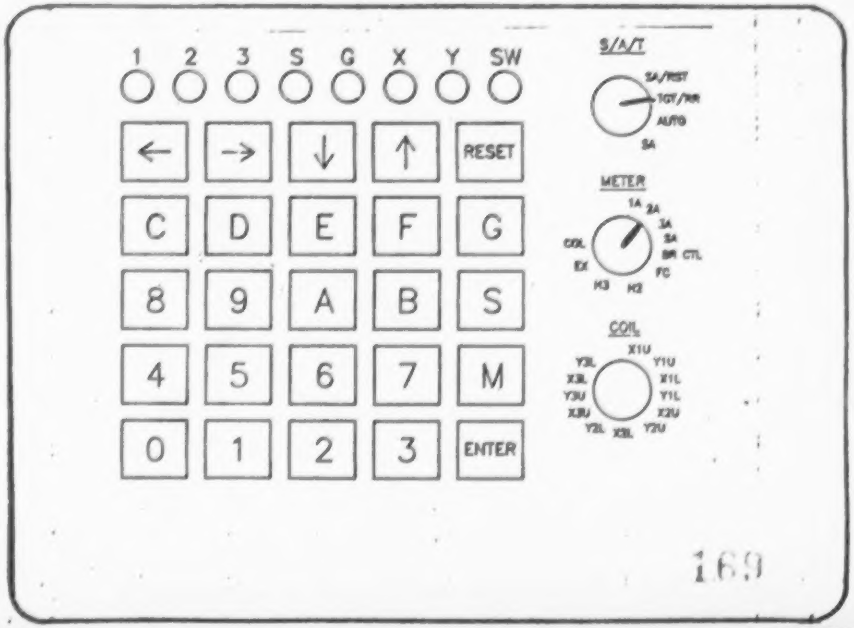
TEXT ☐ ☐, CMD05

B. YOU'RE DOING GREAT.

COMPUTER OVERLAY


B.
CMD Ø5
NEXT

VIDEO


1 2 3 S G X Y SW
S/A/T
← → ↓ ↑ RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
METER
COIL

PROJECT: IBM EL-3 #27 DATE: Nov 89 EVENT: 3.1.2.3 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ____________ CHYRON #: ____________

Graphic Title: IBM 1B Disk: ____________

SOURCE SMPTE: ___:___:___:___ DURATION: ___:___:___

MASTER SMPTE: ___: 07: 46: 28 DURATION: ___: 00: 04

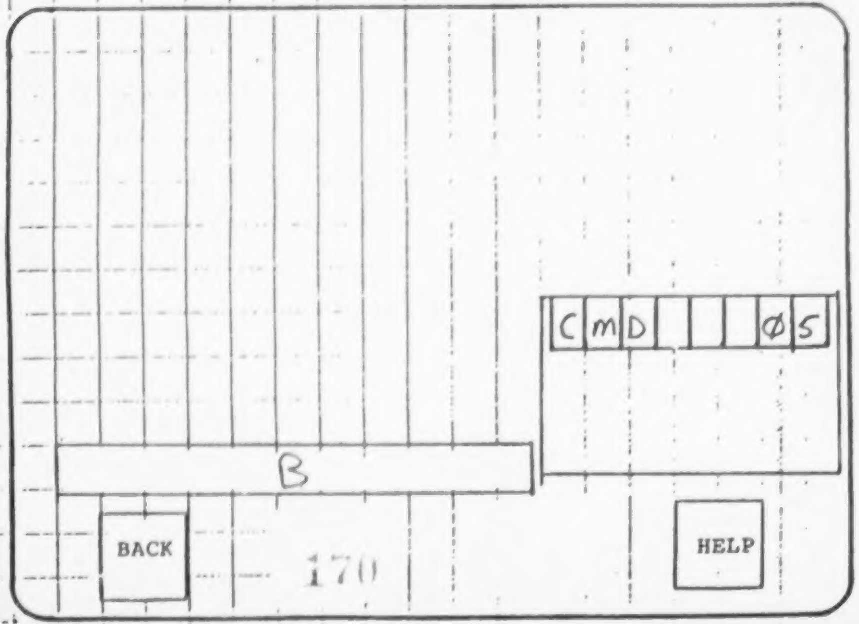
TEXT ☐ ☐ OTHER

B. HOW DO YOU ENTER YOUR SELECTION?

B. PRESS THE "ENTER" KEY TO ENTER YOUR SELECTION.

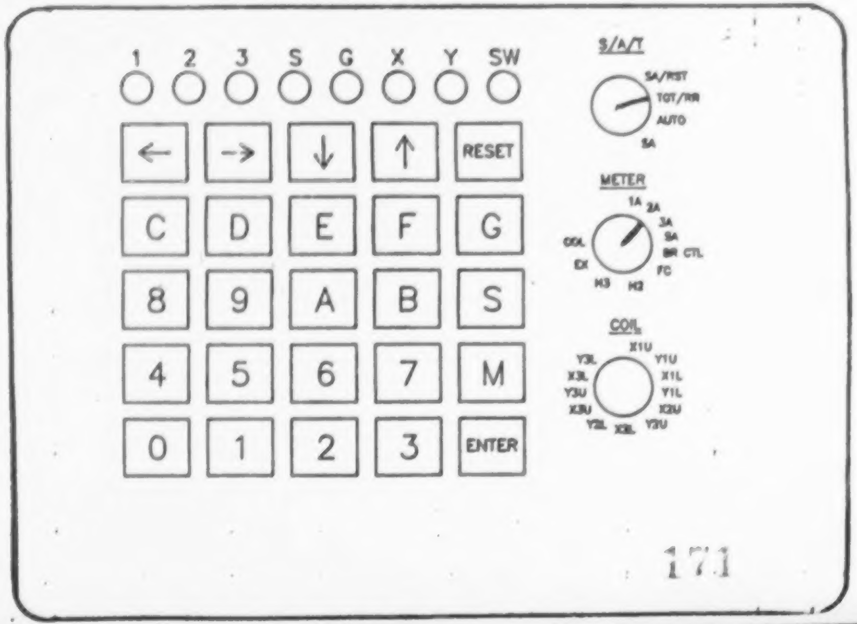
B. NO, THATS NOT IT, TRY AGAIN.

COMPUTER OVERLAY



CMD 05
B
BACK
HELP

VIDEO



1 2 3 S G X Y SW
← → ↓ ↑ RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TOT/RR
AUTO
SA
METER
1A 2A 3A SA BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y3U X3L Y2L X3U Y3L

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.2.3 COL: REDNF

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809-6812

ABEKAS #:________ CHYRON #:________

Graphic Title: IBM 1B Disk:________

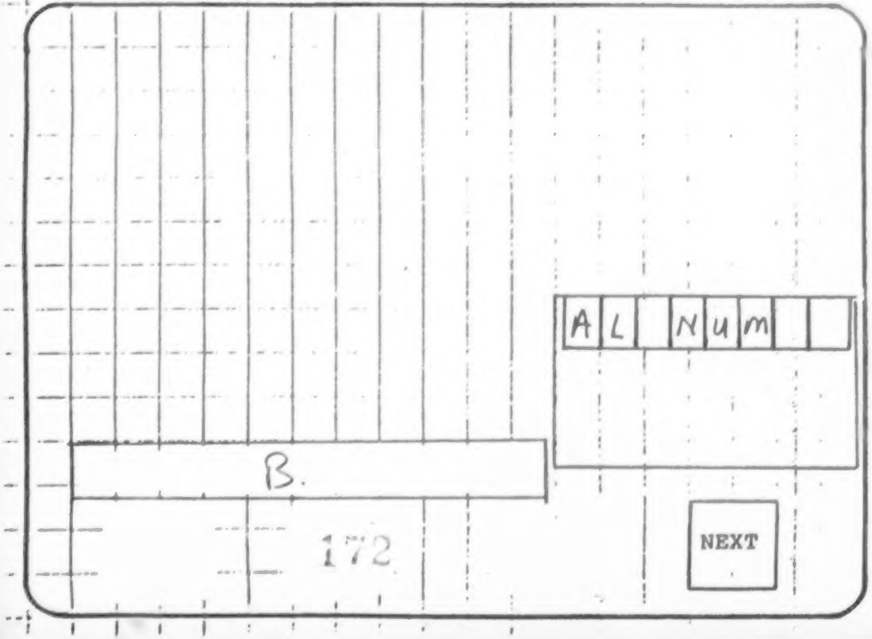
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

MASTER SMPTE: __:07:46:28 DURATION: __:00:04

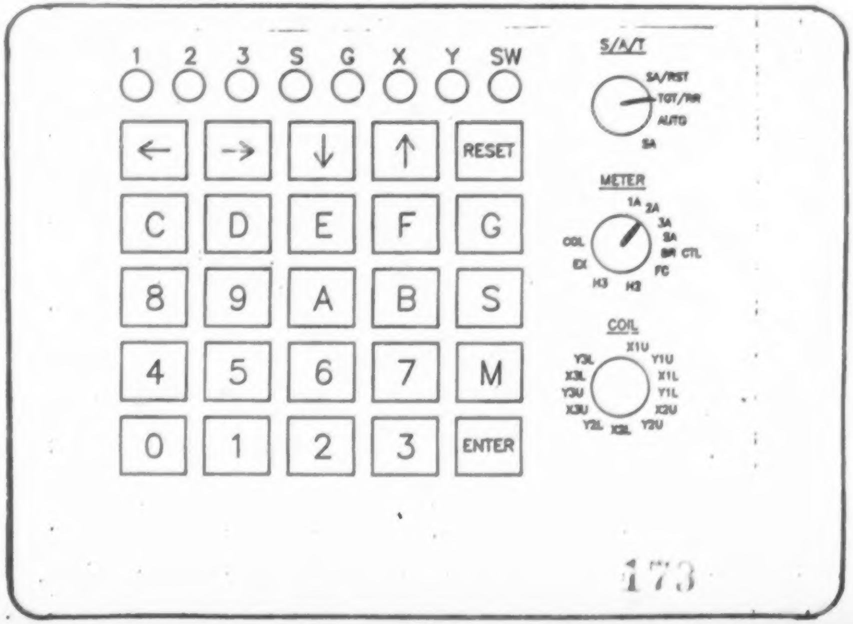
TEXT ☐ ☐ AL Num

B. EXCELLENT!

COMPUTER OVERLAY


AL Num
B.
NEXT

VIDEO


1 2 3 S G X Y SW
←
→
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TGT/RR
AUTO
SA
METER
1A 2A 3A SA BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y2U X2L Y2L X3U Y3U X3L Y3L

PROJECT: IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2.4 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ______ CHYRON #: ______
Graphic Title: IBM 1B Disk: ______
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __: 07: 46: 28 DURATION: __: 00: 04

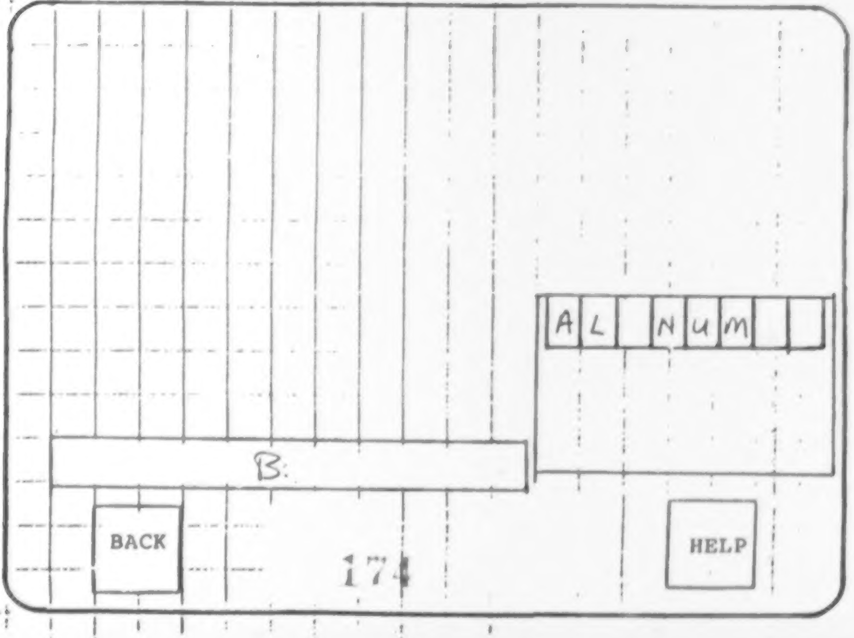
TEXT ☐ ☐ OTHER

B. WHICH KEY WILL ALLOW ADJUSTMENT OF THE 2ND ALIGNMENT?

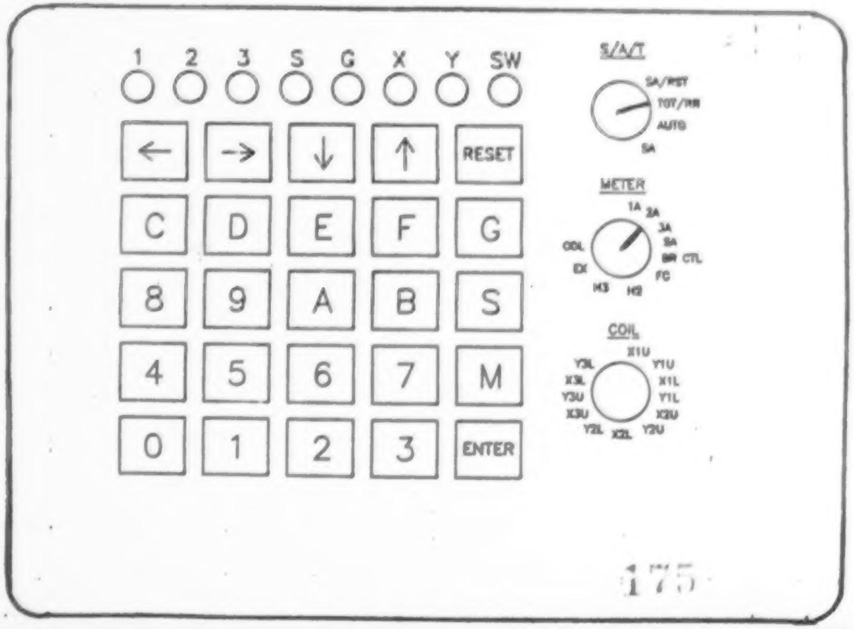
B. TO ALLOW ADJUSTMENT OF THE 2ND ALIGNMENT, PRESS THE "2" KEY.

B. NO, THAT'S NOT IT. TRY AGAIN.

COMPUTER OVERLAY


AL NUM
B:
BACK
HELP

VIDEO


1 2 3 S G X Y SW
← → ↓ ↑ RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TOT/RR
AUTO
SA
METER
1A
2A
3A
SA
BR
CTL
FC
H2
H3
EX
COL
COIL
X1U
Y1U
X1L
Y1L
X2U
Y2U
X2L
Y2L
X3U
Y3U
X3L
Y3L

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.2.4 COL: REINF

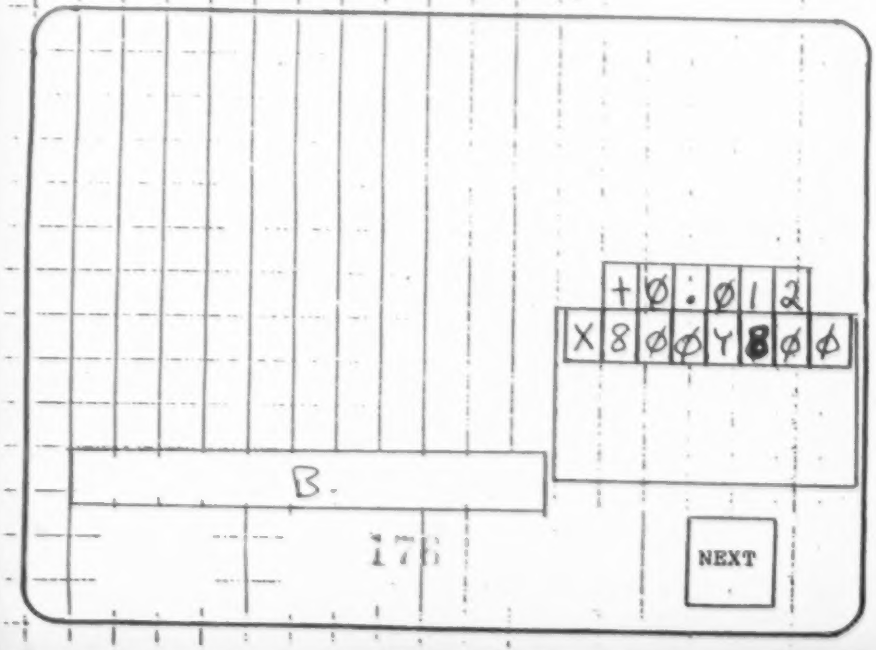
PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809-6812

TEXT ☐ ☐

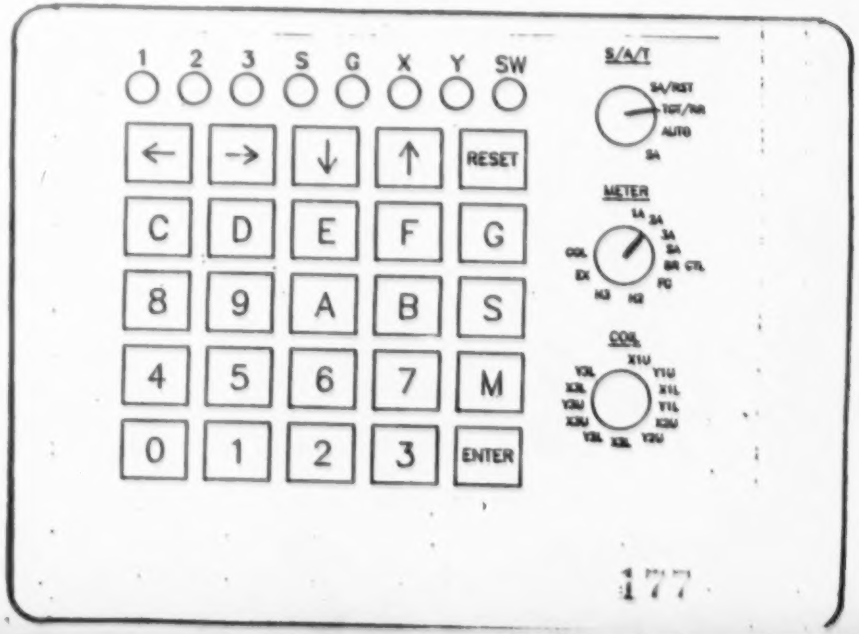
B. YOU'RE DOING GREAT!

ABEKAS #: ______ CHYRON #: ______
Graphic Title: IBM 1B Disk: ______
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __:07:46:28 DURATION: __:00:04

COMPUTER OVERLAY


+0:012
X800Y800
B.
178
NEXT

VIDEO


1 2 3 S G X Y SW
← → ↓ ↑ RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
AUTO
SA
METER
1A
2A
3A
CTL
X1U
Y1U
X1L
Y1L
177

PROJECT: IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2.5 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ____________ CHYRON #: ____________
Graphic Title: IBM 1B Disk: ____________
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __:07:46:28 DURATION: __:00:04

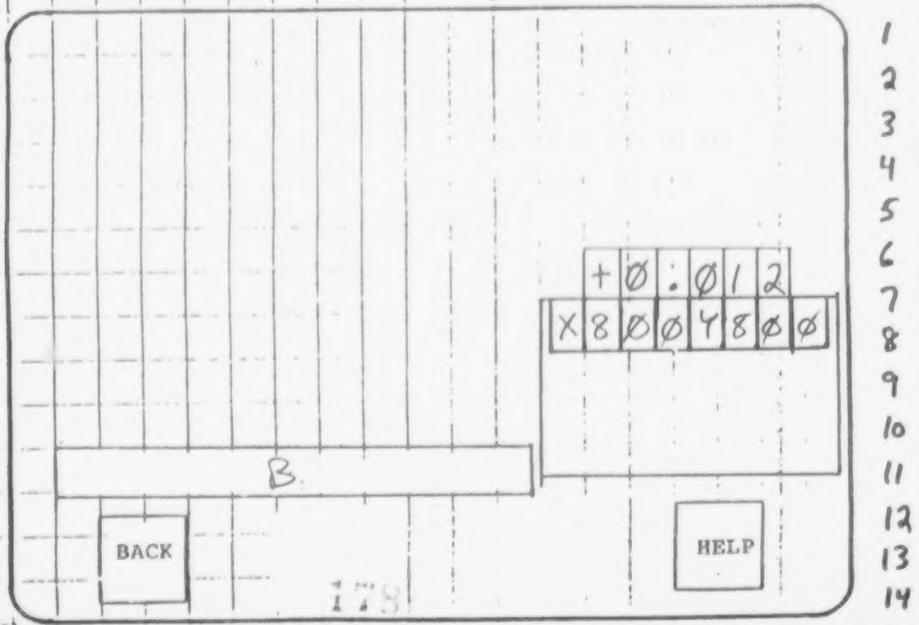
TEXT ☐ ☐ OTHER

B. WHICH KEY WILL CAUSE A DEFLECTION IN THE +X DIRECTION.

B. PRESS THE "RIGHT ARROW" KEY TO CAUSE A +X DEFLECTION.

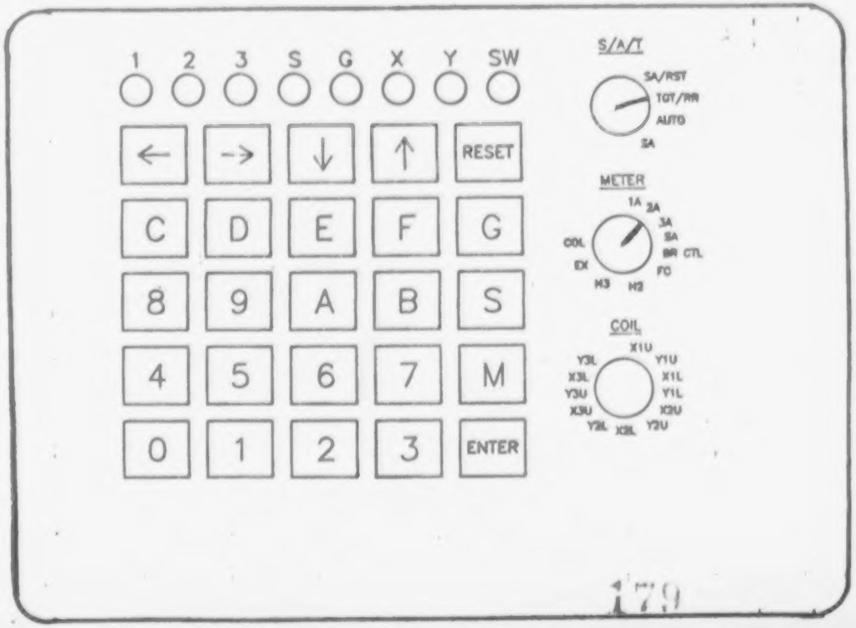
B. NO THATS NOT IT, TRY AGAIN

COMPUTER OVERLAY



+0:012
X800480 0
B.
BACK
HELP
1
2
3
4
5
6
7
8
9
10
11
12
13
14

VIDEO



1 2 3 S G X Y SW
←
->
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TOT/RR
AUTO
SA
METER
1A 2A 3A SA BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y2U X2L Y2L X3U Y3U X3L Y3L

PROJECT: [redacted] IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2.5 COL: DEFL.

PROGRAMMING NOTES: X MISALIGNED 6769-6772
X ONE SIDE 6773-6776

X ALIGNED 6765-6768

ABEKAS #: ______ CHYRON #: ______

Graphic Title: IBM 17/17A/17B Disk: ______

SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

MASTER SMPTE: __:07:45:14 DURATION: __:00:12

TEXT ☐ ☐

X MISALIGNED SHOWN BELOW

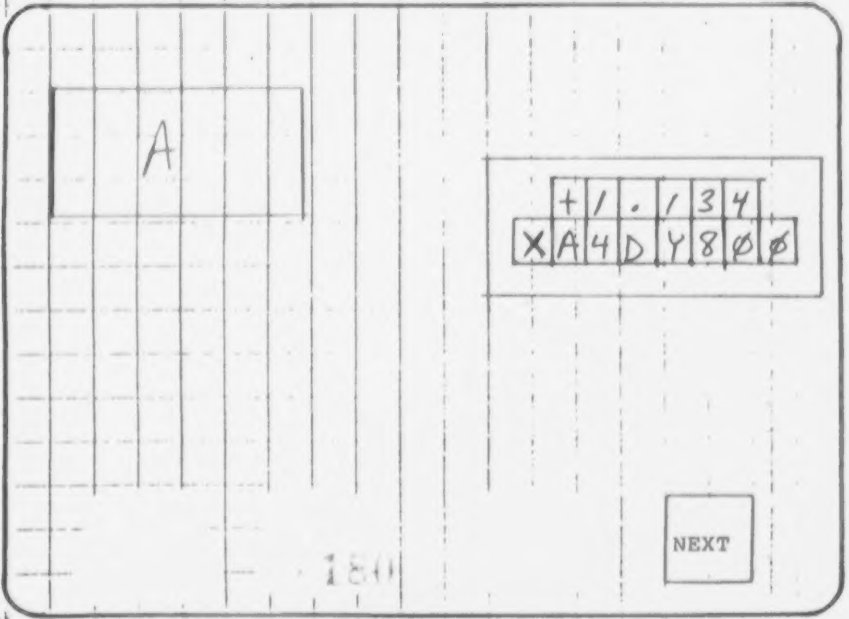
A. THE BEAM IS ONLY HALF DEFLECTED AT THIS POINT.

THE DVM READING IS INCREASING, BUT IT IS NOT MAXIMIZED YET.

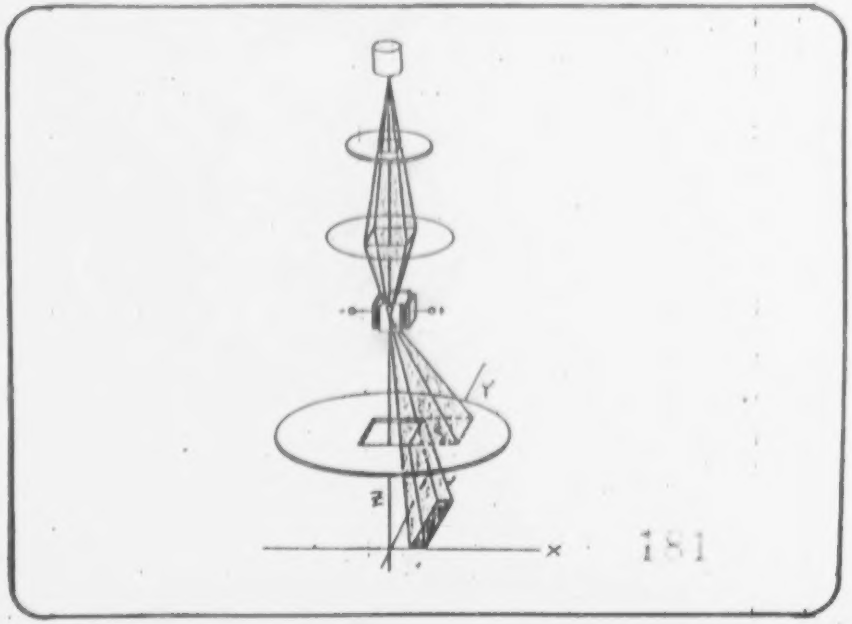
TOUCH NEXT TO RETURN TO THE KEYPAD.

SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

COMPUTER OVERLAY



VIDEO



PROJECT: IBM EL-3 #27 DATE: NOV 89 EVENT: 3.1.2 COL: 1; HELP

PROGRAMMING NOTES: ALIGNMENT BRIGHTNESS FRU
FRAMES: 6809 - 6812

ABEKAS #: ________ CHYRON #: ________

Graphic Title: IBM 1B Disk: ________

SOURCE SMPTE: ___:___:___:___ DURATION: ___:___:___

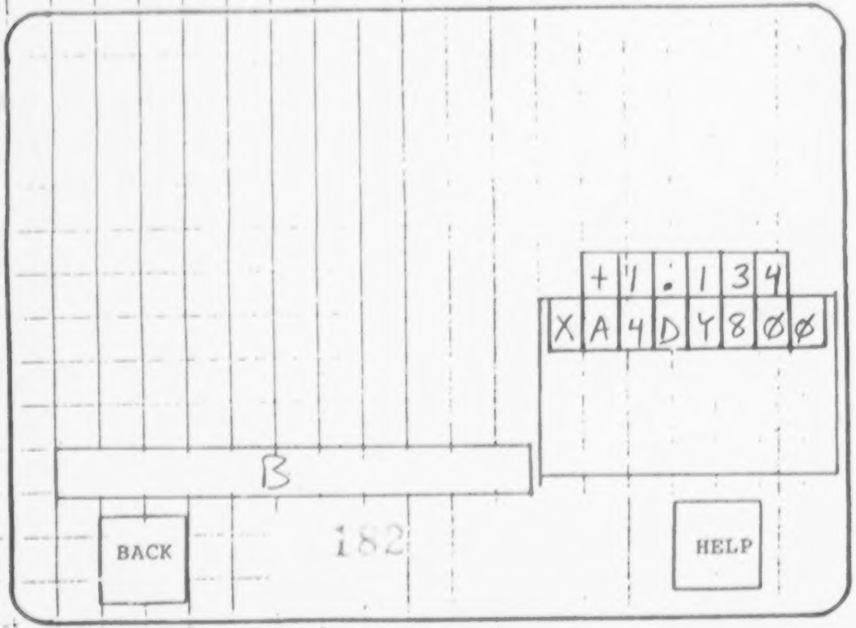
MASTER SMPTE: ___:07:46:28 DURATION: ___:00:04

TEXT ☐ ☐

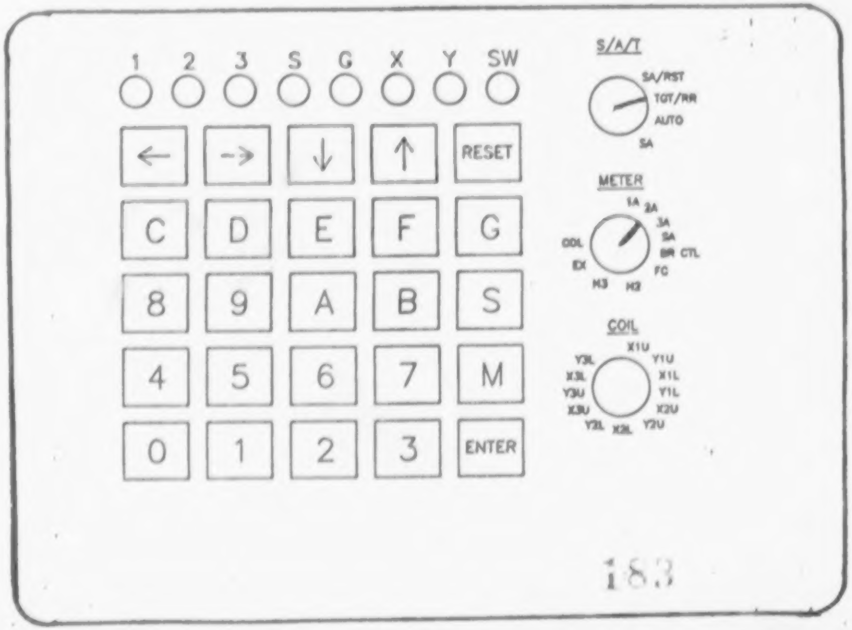
B. THE BEAM IS ONLY HALF DEFLECTED KEEP GOING

B. YOU MUST CONTINUE TO PRESS THE RIGHT ARROW KEY.

COMPUTER OVERLAY


+1:134
XA4DY800
B
BACK
182
HELP

VIDEO


1 2 3 S G X Y SW
←
→
↓
↑
RESET
C D E F G
8 9 A B S
4 5 6 7 M
0 1 2 3 ENTER
S/A/T
SA/RST
TOT/RR
AUTO
SA
METER
1A 2A 3A SA BR CTL FC H2 H3 EX COL
COIL
X1U Y1U X1L Y1L X2U Y2U X2L Y2L X3U Y3U X3L Y3L
183

PROJECT: IBM EL-3 #27 DATE: NOV. 89 EVENT: 3.1.2 COL: DEFL.

PROGRAMMING NOTES: X MISALIGNED 6769-6772
X ONE SIDE 6773-6776

X ALIGNED 6765-6768

ABEKAS #: ______ CHYRON #: ______
Graphic Title: IBM 17/17A/17B Disk: ______
SOURCE SMPTE: __:__:__:__ DURATION: __:__:__
MASTER SMPTE: __:07:45:14 DURATION: __:00:12

TEXT ☐ ☐

X ONE SIDE SHOWN BELOW

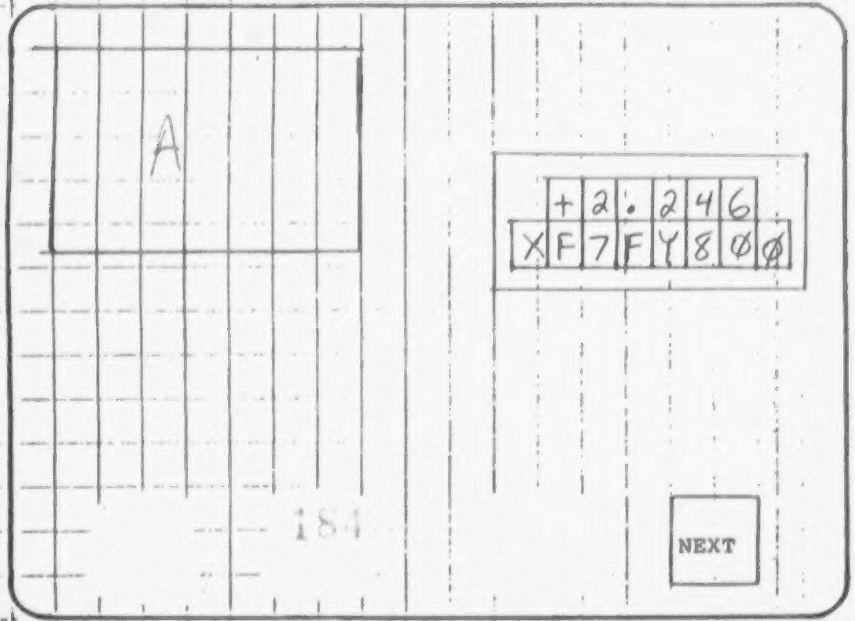
A. THE BEAM IS FULLY DEFLECTED TO ONE SIDE, AND THE DVM READING IS AT A MAXIMUM

ALL OF THE BEAM IS STRIKING THE PLATE
NONE OF THE BEAM IS PASSING THROUGH THE 2ND APERTURE.

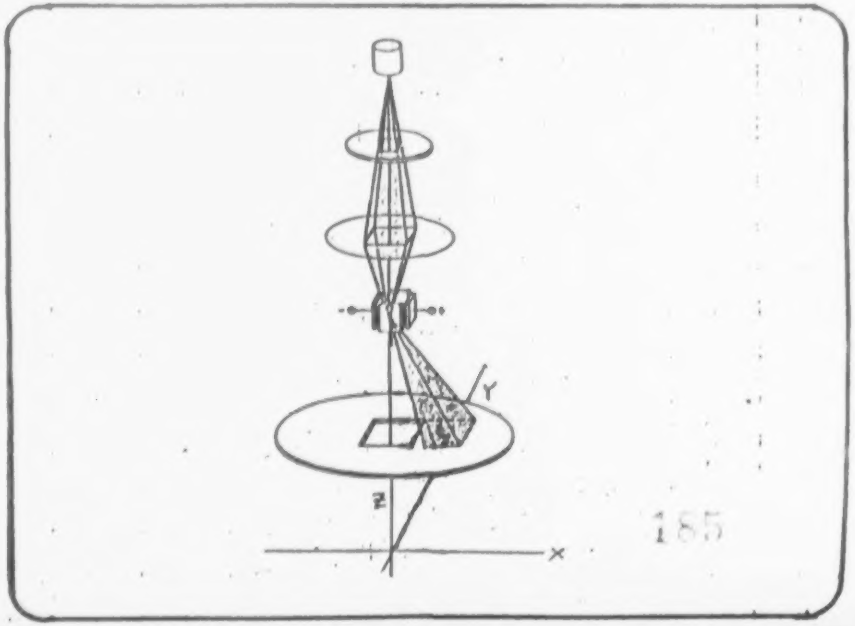
TOUCH NEXT TO CONTINUE

SOURCE SMPTE: __:__:__:__ DURATION: __:__:__

COMPUTER OVERLAY

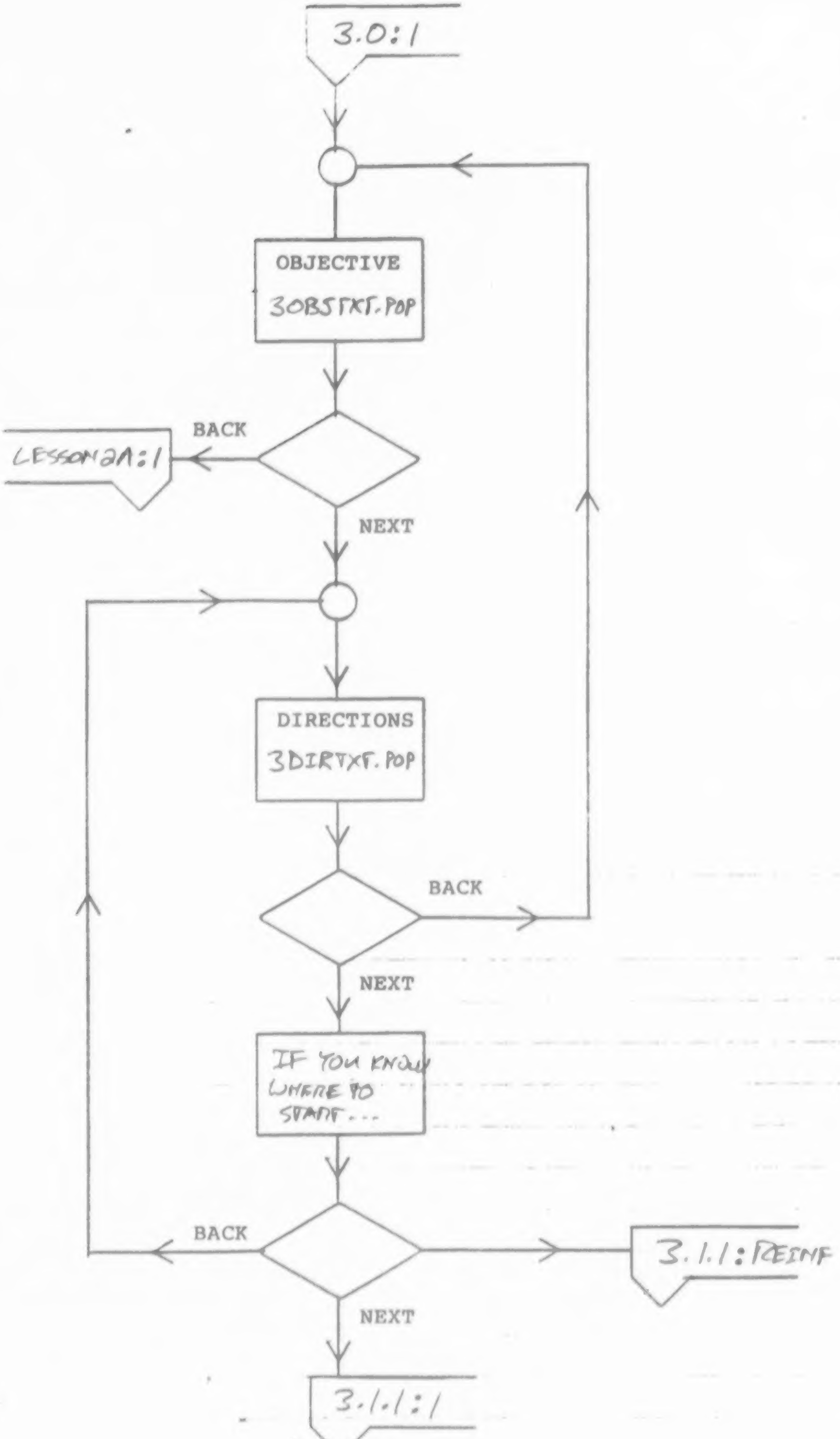


VIDEO

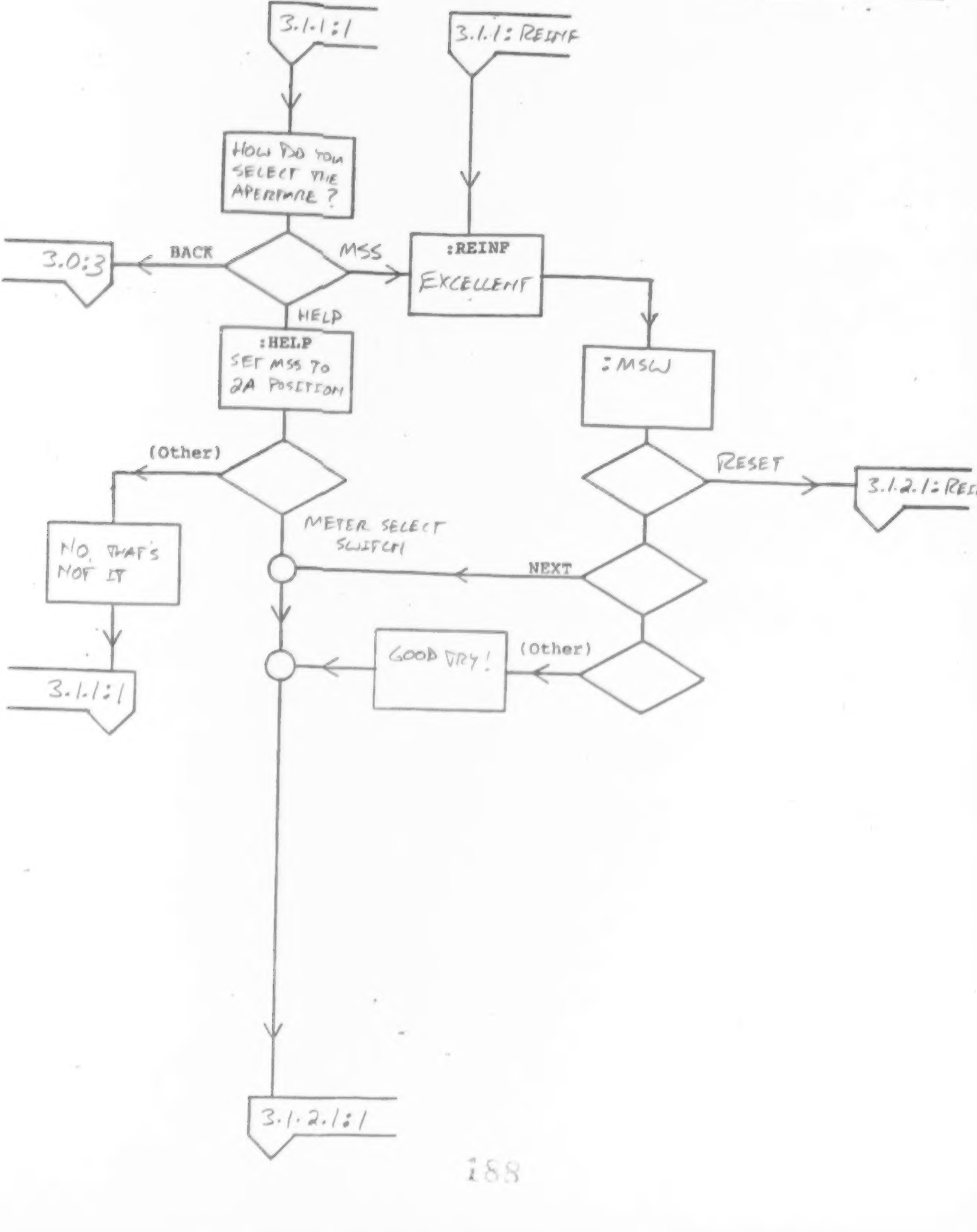


APPENDIX F

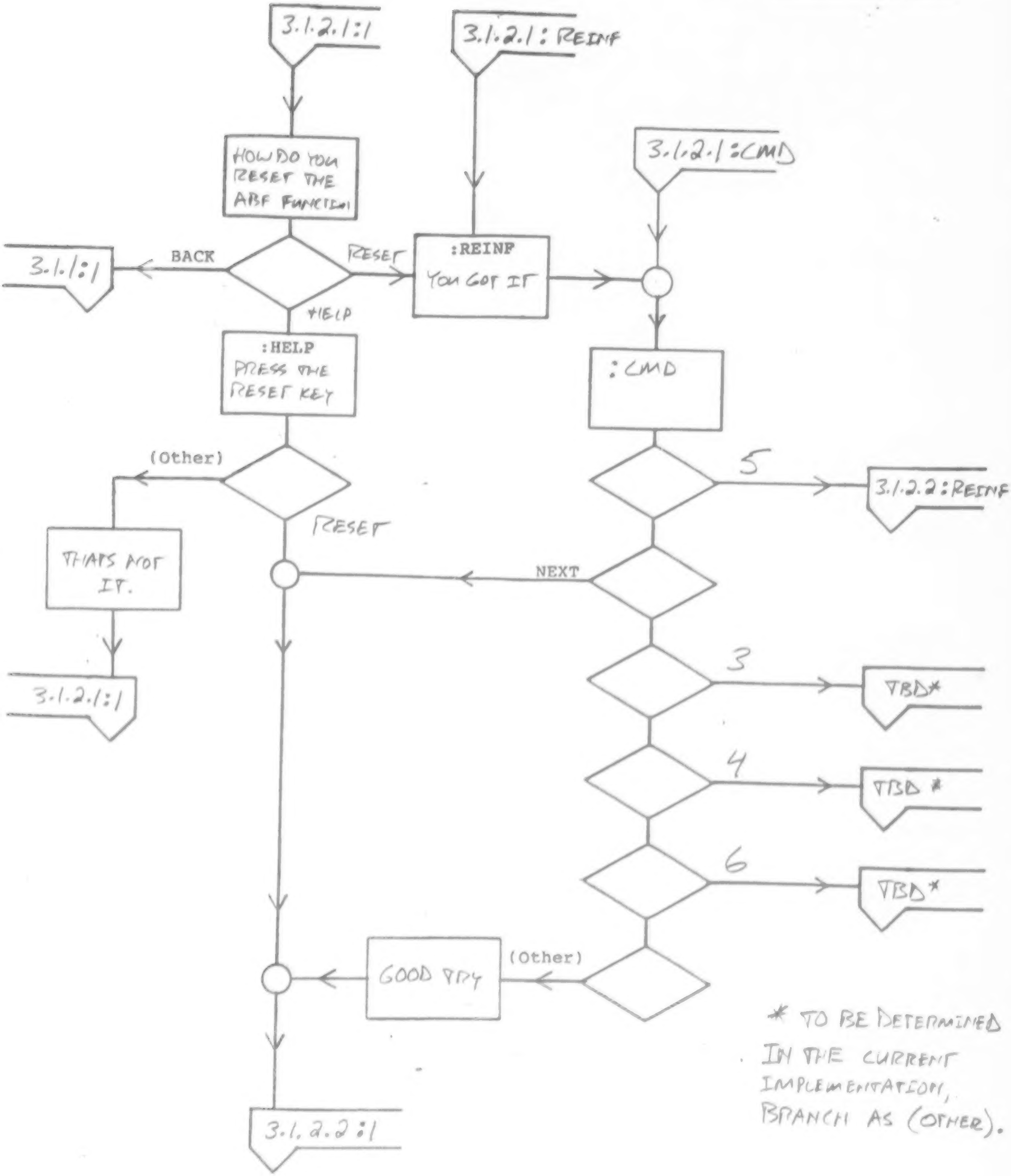
FLOWCHARTS


3.0:1
OBJECTIVE
3OBSTXT.POP
BACK
LESSON2A:1
NEXT
DIRECTIONS
3DIRTXT.POP
BACK
NEXT
IF YOU KNOW WHERE TO START...
BACK
3.1.1:PREINF
NEXT
3.1.1:1

EVENT 3.1.1

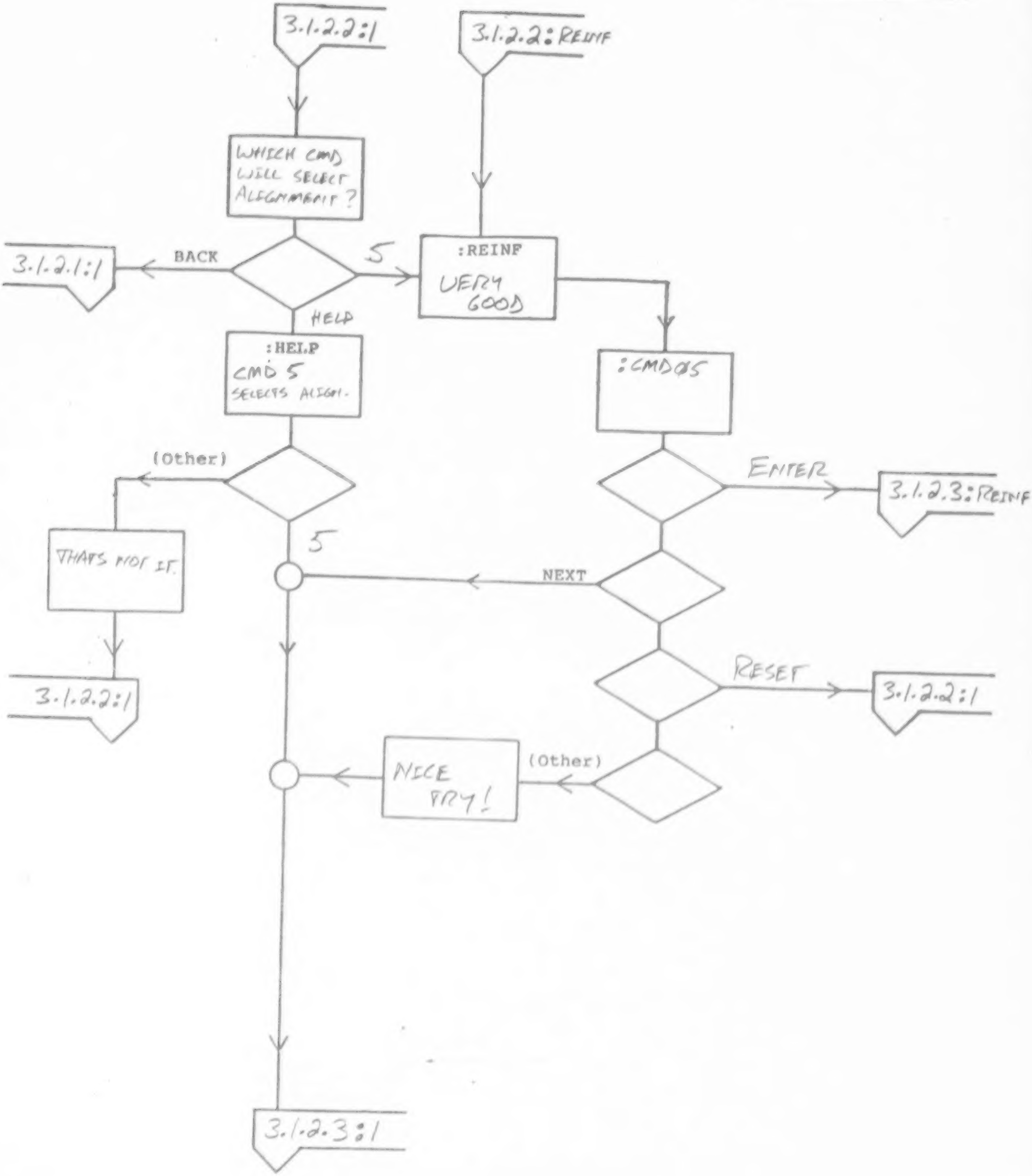

3.1.1:1
3.1.1: REINF
HOW DO YOU SELECT THE APERTURE ?
BACK
3.0:3
MSS
:REINF
EXCELLENT
HELP
:HELP
SET MSS TO 2A POSITION
:MSW
(Other)
RESET
3.1.2.1: REINF
METER SELECT SWITCH
NO, THAT'S NOT IT
NEXT
GOOD TRY!
(Other)
3.1.1:1
3.1.2.1:1

EVENT 3.1.2.1

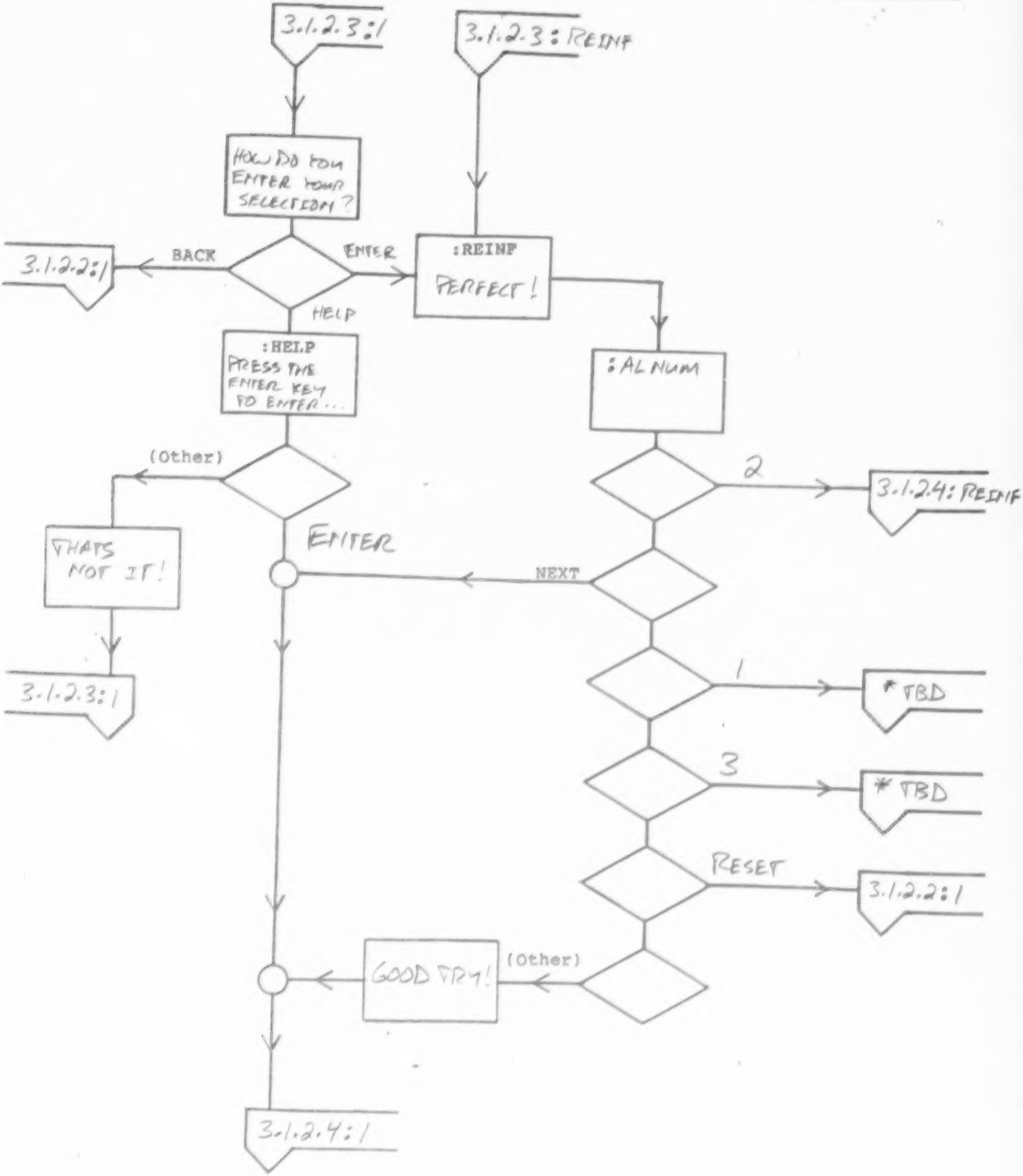

3.1.2.1:1
3.1.2.1: REINF
HOW DO YOU RESET THE ABF FUNCTION
3.1.2.1:CMD
3.1.1:1
BACK
RESET
:REINF
YOU GOT IT
HELP
:HELP
PRESS THE RESET KEY
:CMD
(Other)
RESET
5
3.1.2.2:REINF
THATS NOT IT.
NEXT
3.1.2.1:1
3
TBD*
4
TBD *
6
TBD*
GOOD TRY
(Other)
3.1.2.2:1

* TO BE DETERMINED IN THE CURRENT IMPLEMENTATION, BRANCH AS (OTHER).

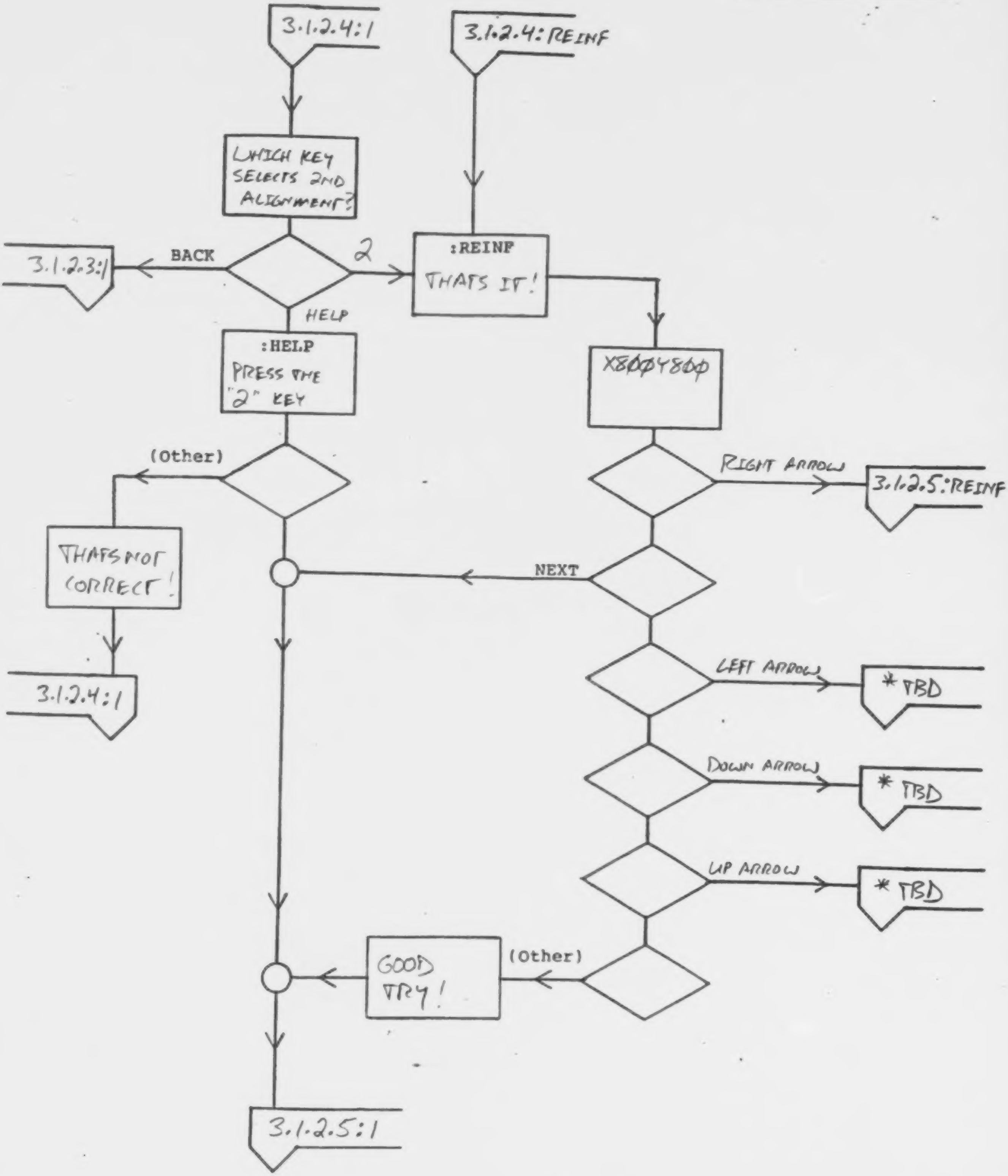
EVENT 3.1.2.2


3.1.2.2:1
3.1.2.2:REINF
WHICH CMD WILL SELECT ALIGNMENT?
BACK
3.1.2.1:1
5
:REINF
VERY GOOD
HELP
:HELP
CMD 5 SELECTS ALIGN.
:CMD05
(Other)
ENTER
3.1.2.3:REINF
THATS NOT IT.
5
NEXT
3.1.2.2:1
RESET
3.1.2.2:1
NICE TRY!
(Other)
3.1.2.3:1

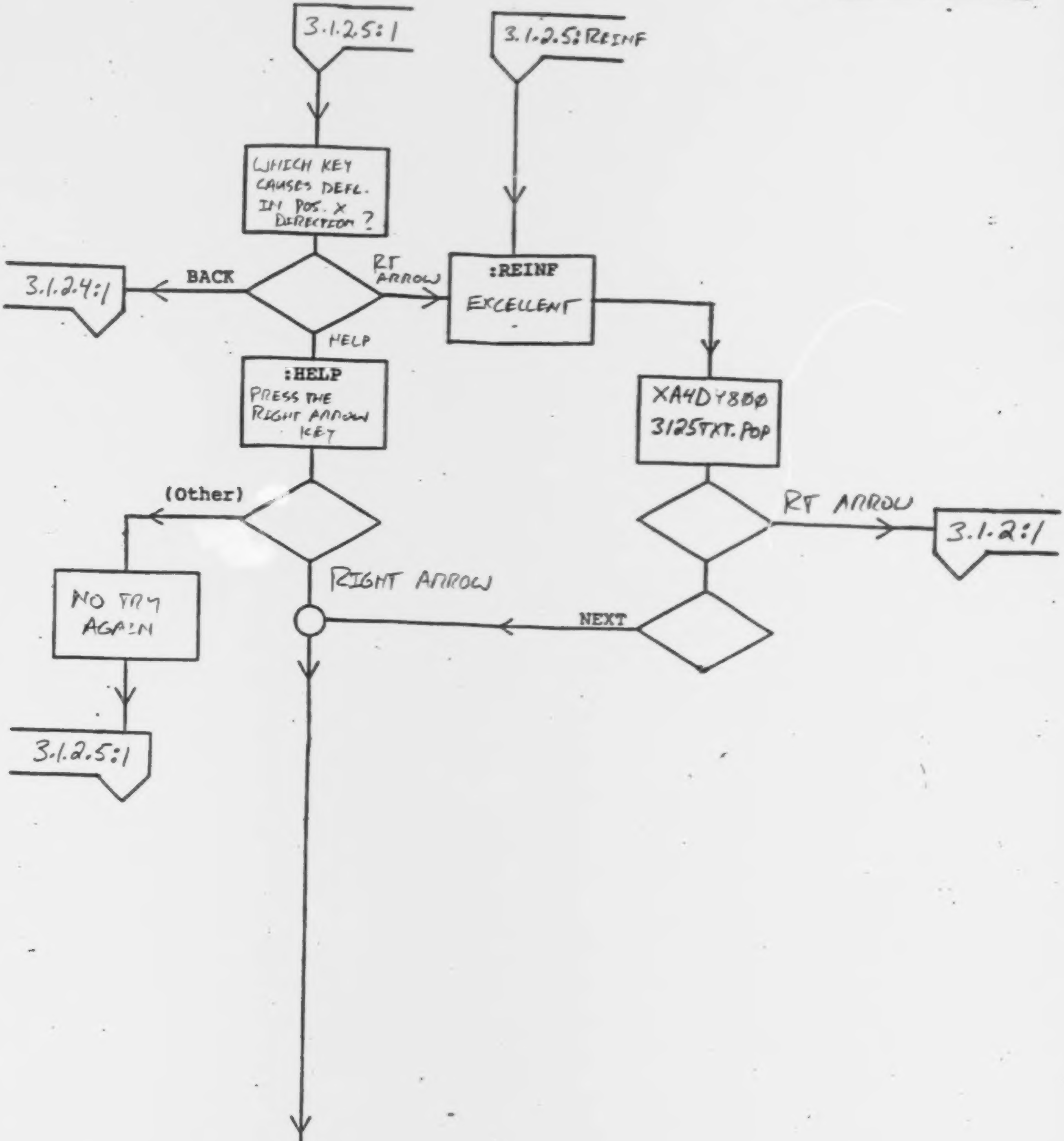
EVENT 3.1.2.3


3.1.2.3:1
3.1.2.3:REINF
HOW DO YOU ENTER YOUR SELECTION?
BACK
3.1.2.2:1
ENTER
:REINF
PERFECT!
HELP
:HELP
PRESS THE ENTER KEY TO ENTER...
:ALNUM
(Other)
ENTER
2
3.1.2.4:REINF
THATS NOT IT!
NEXT
3.1.2.3:1
1
*TBD
3
*TBD
RESET
3.1.2.2:1
(Other)
GOOD TRY!
3.1.2.4:1

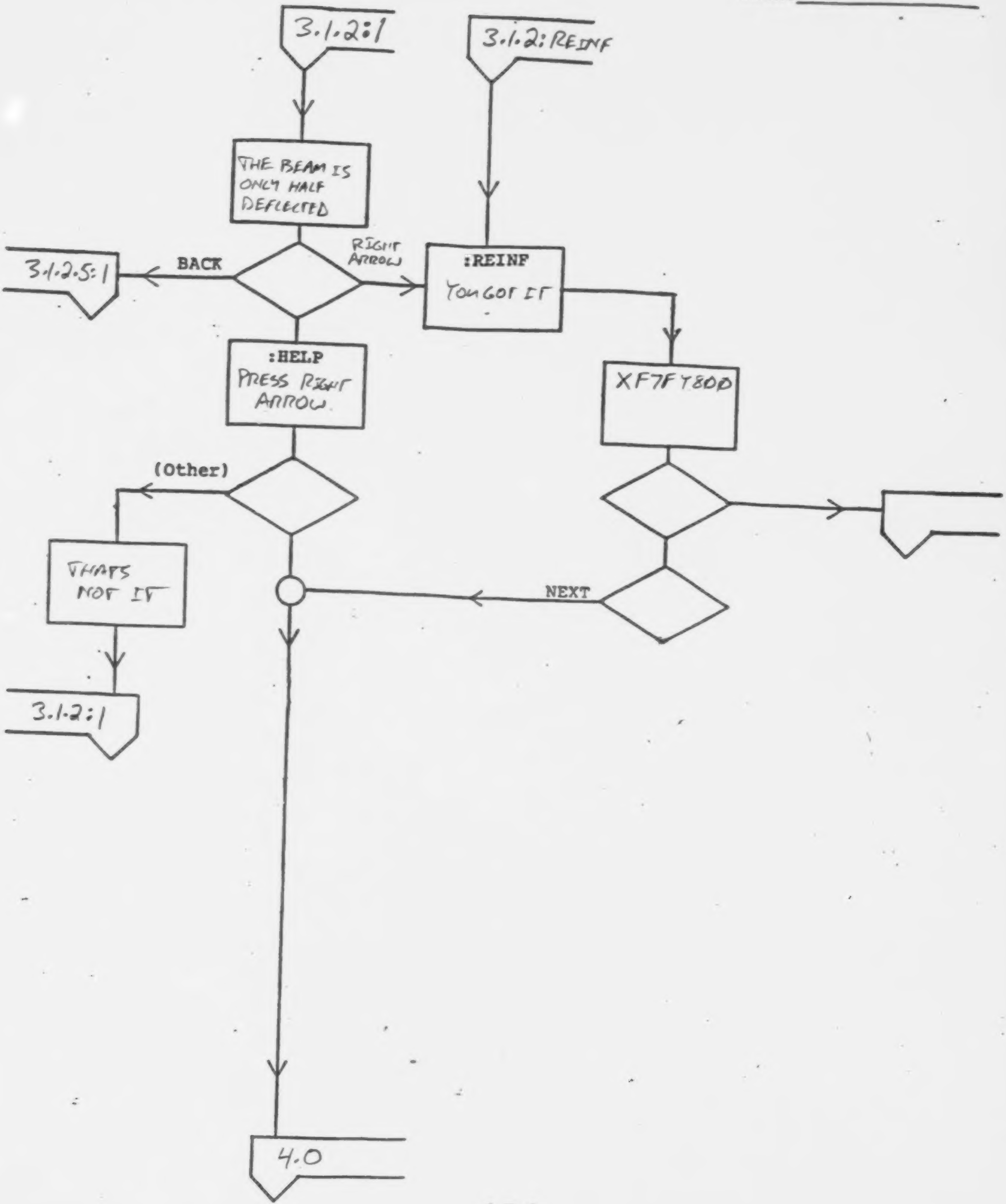
EVENT 3.1.2.4


3.1.2.4:1
3.1.2.4:REINF
WHICH KEY SELECTS 2ND ALIGNMENT?
BACK
3.1.2.3:1
2
:REINF
THATS IT!
HELP
:HELP
PRESS THE "2" KEY
X800Y800
(Other)
RIGHT ARROW
3.1.2.5:REINF
THATS NOT CORRECT!
NEXT
3.1.2.4:1
LEFT ARROW
*TBD
DOWN ARROW
*TBD
UP ARROW
*TBD
GOOD TRY!
(Other)
3.1.2.5:1

EVENT 3.1.2.5


3.1.2.5:1
3.1.2.5:REINF
WHICH KEY CAUSES DEFL. IN POS. X DIRECTION ?
BACK
3.1.2.4:1
RT ARROW
:REINF
EXCELLENT
HELP
:HELP
PRESS THE RIGHT ARROW KEY
XA4DY800
3125TXT.POP
(Other)
RT ARROW
3.1.2:1
NO TRY AGAIN
RIGHT ARROW
NEXT
3.1.2.5:1
3.1.2:1

EVENT 3.1.2


3.1.2:1
3.1.2:REINF
THE BEAM IS ONLY HALF DEFLECTED
3.1.2.5:1
BACK
RIGHT ARROW
:REINF
YOU GOT IT
:HELP
PRESS RIGHT ARROW
XF7FY80D
(Other)
THATS NOT IT
NEXT
3.1.2:1
4.0

APPENDIX G

PRESENTATION OUTLINE

```
################################################################
###                   LEARNING ACTIVITY THREE                ###
################################################################


*3.0 Objective Page
     Graphic: BKNXT
     Literal: 3OBJTXT.POP
      Branch -
          Next: :2
          Back: LESSON2A


 3.0:2
     Graphic: BKNXT
     Literal: 3DIRTXT.POP
      Branch -
          Back: :1
          Next: :3

  3.0:3
     Graphic: BKNXT
     Literal: "If you know where to start, go ahead.
               Otherwise, touch NEXT."
      Branch -
          Back: 3.0:1
          Next: 3.1.1:1
           MSS: 3.1.1:REINF
       (other): 3.1.1:1
```

```
###                       BEGIN SIMULATION                       ###
####################################################################
###                            3.1.1                             ###
####################################################################


*3.1.1 Set Meter Select Switch to 2A.
     Graphic: HLPBK
     Literal: "How do you select which alignment to monitor?"
       Vdisk: 6810
       Touch: 311
      Branch -
          Back: 3.0B
          Help: :HELP
           MSW: :MSW
       (other): +1; "No, that's not it"

 3.1.1:HELP
     Graphic: clearhi
     Literal: "Touch the Meter Select Switch"
       Vdisk: 6810
       Touch:
      Branch -
           MSW: +1
       (other): +1; "No, that's not it"

 3.1.1:REINF
     Graphic: clearhi
     Literal: "That's It!"
       Vdisk: 6810
       Touch:
      Branch -
              :MSW


 3.1.1:MSW
     Graphic: NEXT
     Literal:
       Vdisk: 6810
       Touch:
      Branch -
          Next: 3.1.2.1
         RESET: 3.1.2.1:RESET
       (other): +1; "No, that's not it"
```

```
###################################################################
###                           3.1.2.1                           ###
###################################################################


*3.1.2.1 Depress RESET
     Graphic: HLPBK
     Literal: 3121 "How do you reset the ABF function keypad"
       Vdisk: 6810
       Touch: 3121
      Branch -
         Back: 3.1.2
         Help: :HELP
        Reset: :REINF
      (other): +1; "No, that's not it"

 3.1.2.1:HELP
     Graphic: clearhi
     Literal: "Press the RESET key"
       Vdisk: 6810
       Touch:
      Branch -
        RESET: 3.1.2.2
      (other): +1; "No, that's not it"

 3.1.2.1:REINF
     Graphic: clearhi
     Literal: "That's It!"
       Vdisk: 6810
       Touch:
      Branch -
              :CMD

 3.1.2.1:CMD
     Graphic: NEXT; CMD
       Vdisk: 6810
       Touch:
      Branch -
         Next: 3.1.2.2
            5: 3.1.2.2:REINF
      (other): +1; "No, that's not it"
```

```
################################################################
###                          3.1.2.2                         ###
################################################################


*3.1.2.2 Depress 5
     Graphic: HLPBK
     Literal: "Which command will select
               alignment procedures?"
       Vdisk: 6810
       Touch: 3122
      Branch -
          Back: 3.1.2.1
          Help: :HELP
             5: :CMD05
       (other): +1; "No, that's not it"

 3.1.2.2:HELP
     Graphic: clearhi
     Literal: "Command 5 accesses the alignment
               procedures, press 5"
       Vdisk: 6810
       Touch:
      Branch -
             5: 3.1.2.3
       (other): +1; "No, that's not it"

 3.1.2.2:REINF
     Graphic: clearhi
     Literal: "Very Good!"
       Vdisk: 6810
       Touch:
      Branch -
              :CMD05

 3.1.2.2:CMD05
     Graphic: NEXT; CMD05
       Touch:
      Branch -
          Next: 3.1.2.3
         Enter: 3.1.2.3:REINF
         Reset: 3.1.2.1:CMD
       (other): +1; "No, that's not it"
```

```
################################################################
###                          3.1.2.3                         ###
################################################################


*3.1.2.3 Depress ENTER
     Graphic: HLPBK
     Literal: "How do you enter your selection?"
       Vdisk: 6810
       Touch: 3123
      Branch -
          Back: 3.1.2.2
          Help: :HELP
         Enter: :ALNUM

 3.1.2.3:HELP
     Graphic: clearhi
     Literal: "Press the ENTER key to enter your selection"
       Vdisk: 6810
       Touch:
      Branch -
         Enter: 3.1.2.4
       (other): +1; "No, that's not it"

 3.1.2.3:REINF
     Graphic: clearhi
     Literal: "Pefect!"
       Vdisk: 6810
       Touch:
      Branch -
              :ALNUM

 3.1.2.3:ALNUM
     Graphic: NEXT; ALNUM
       Touch:
      Branch -
          Next: 3.1.2.4
             2: 3.1.2.4:REINF
         Reset: 3.1.2.1:CMD
       (other): +1; "No, try again"
```

```
######################################################################
###                            3.1.2.4                             ###
######################################################################


*3.1.2.4 Depress 2
     Graphic: HLPBK
     Literal: "Which key will allow adustment
               of the 2nd alignment?"
       Vdisk: 6810
       Touch: 3124
      Branch -
          Help: :HELP
          Back: 3.1.2.3
             2: :REINF

 3.1.2.4:HELP
     Graphic: clearhi
     Literal: "To allow adjustment of the 2nd
               alignment, press the 2 key"
       Vdisk: 6810
       Touch:
      Branch -
             2: 3.1.2.5
       (other): +1; "No, that's not it"

 3.1.2.4:REINF
     Graphic: clearhi
     Literal: "Pefect!"
       Vdisk: 6810
       Touch:
      Branch -
              :X800Y000

 3.1.2.4:X800Y800
     Graphic: X800Y800
       Touch:
      Branch -
          Next: 3.1.2.5
         Reset: 3.1.2.1:CMD
         Enter: 3.1.2.3:ALNUM
         RTARW: 3.1.2.5:REINF
       (other): +1; "No, that's not it"
```

```
################################################################
###                         3.1.2.5                          ###
################################################################


*3.1.2.5 Right Arrow key
     Graphic: HLPBK
     Literal: "Use the right arrow key to deflect the
               beam in the positive X direction"
       Vdisk: 6810
       Touch: 3125
      Branch -
          Help: :HELP
          Back: 3.1.2.4
         Right: :DEFL
       (other): +1; "No, that's not it"

 3.1.2.5:HELP
     Graphic: clearhi
     Literal: "To allow adjustment of the 2nd
               alignment, press the 2 key"
       Vdisk: 6810
       Touch:
      Branch -
             2: 3.1.2.5
       (other): +1; "No, that's not it"

 3.1.2.5:REINF
     Graphic: clearhi
     Literal: "Pefect!"
       Vdisk: 6810
       Touch:
      Branch -
              :X800Y000

 3.1.2.5:DEFL
     Graphic: NEXT
     Literal: 3125TXT.POP
       Vdisk: 6770  (alignment graphic; half deflection)
       Touch:
      Branch -
          Next: 3.1.2.1
          Back: 3.1.2
          Menu: MAIN
```

```
#################################################################
###                           3.1.2                           ###
#################################################################


*3.1.2  2nd Alignment set to one side
     Graphic: MNBKNXT
     Literal:
       Vdisk: 6774  (alignment graphic; full deflection)
   Highlight:
       Touch:
      Branch -
          Next: 4.0
          Back: 3.1.2.5
          Menu: MAIN

 3.1.2:HELP
     Graphic: clearhi
     Literal:
       Vdisk: 6810
       Touch:
      Branch -
             2: 3.1.2.5
       (other): +1; "No, that's not it"

 3.1.2:REINF
     Graphic: clearhi
     Literal: "Pefect!"
       Vdisk: 6810
       Touch:
      Branch -
              :DEFL

 3.1.2:DEFL
     Graphic: NEXT
     Literal:
       Vdisk: 6774  (alignment graphic; full deflection)
       Touch:
      Branch -
          Next: 3.2.2.1
          Back: 3.1.2.5
```

APPENDIX H

IWPS PRESENTATION DOCUMENTATION

```
 Event Detail for Presentation ALIGN2     Event 3.0          9 of 23  Events

Time                                                                    Column

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

    GRAPHIC BKNXT              Wipe = None
                               Colors: Trans. = BLACK       Border = BLUE
                               FULL SCREEN      Mode = HI

    Text POPUP a:3objtxt.pop at  5, 8;14,74. Color is HI WHITE on GRAY

    TOUCH LSN3A             Tch  Rows   Cols  Branch
                             #                Feedback
                             1  21,25  63,76  +1
                                              GOOD BEEP
                             2  21,25   5,18  LESSON2A:1
                                              GOOD BEEP

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

    Text POPUP A:3dirtxt.pop at  1, 8;19,74. Color is HI WHITE on GRAY

    TOUCH LSN3B             Tch  Rows   Cols  Branch
                             #                Feedback
                             1  21,25  63,76  +1
                                              GOOD BEEP
                             2  21,25   4,18  -1
                                              GOOD BEEP

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 3

    STILL FRAME  6810 on Player 1

    GRAPHIC BKNXT              Wipe = Dissolve              Time =  0.0 seconds
                               Colors: Trans. = BLUE        Border = BLUE
                               FULL SCREEN      Mode = HI

    LITERAL LSN30     at 20, 3  Colors: Before = YELLOW on WHITE
                                        After  = YELLOW on WHITE
          " If you know where to start, go ahead.  Otherwise, touch NEXT.   "

    TOUCH LSN3C             Tch  Rows   Cols  Branch
                             #                Feedback
                             1  21,25  63,76  3.1.1:1
                                              GOOD BEEP
                             2  21,25   5,18  3.0:1
                                              GOOD BEEP
                             3   5,13  50,72  3.1.1:REINF
                                              GOOD BEEP
```

```
                        4   1,20   4,74  3.1.1:1
                                         GOOD BEEP

     0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4

        BRANCH TO NEXT EVENT 3.1.1
```

```
 Event Detail for Presentation ALIGN2     Event 3.1.1        10 of 23  Events

Time                                                                      Columr

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

     STILL FRAME  6810 on Player 1

     GRAPHIC BKHLP            Wipe = Dissolve                 Time =  0.0 seconds
                              Colors: Trans. = BLUE           Border = BLUE
                              FULL SCREEN      Mode = HI

     LITERAL 311P      at 20, 4  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                        "How do you select the Aperture to monitor with the DVM?"

     TOUCH 311                 Tch  Rows   Cols  Branch
                                #                Feedback
                                1  21,25  63,76  :HELP
                                                 GOOD BEEP
                                2  21,25   5,18  3.0:3
                                                 GOOD BEEP
                                3   5,13  51,71  :MSW
                                                 GOOD BEEP
                                4   3,20   4,49  :OTHER
                                                 BAD BEEP

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 2

     CLEARHI to BLUE with BLUE Border and BLUE Transparent

     LITERAL 311       at 20, 5  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                 "Set Meter Select Switch to the 2A position.                   "

     TOUCH 311H                Tch  Rows   Cols  Branch
                                #                Feedback
                                1   5,13  50,72  3.1.2.1:1
                                                 GOOD BEEP
                                2   1,20   4,73  :OTHER
                                                 GOOD BEEP

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 3

     LITERAL 311R      at 20, 3  Colors: Before = LT GREEN on BLUE
                                        After  = LT GREEN on BLUE
                  " Excellent! You're off to a great start.                     "

     BRANCH TO +1
```

```
2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4

    BRANCH TO :MSW

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - MSW # 5

    GRAPHIC NEXT             Wipe = Dissolve                Time =  0.0 seconds
                             Colors: Trans. = BLUE          Border = BLUE
                             FULL SCREEN       Mode = HI

    TOUCH 311N            Tch  Rows   Cols  Branch
                           #                Feedback
                           1  21,25  63,77  3.1.2.1:1
                                            GOOD BEEP
                           2   3, 7  39,48  3.1.2.1:REINF
                                            GOOD BEEP
                           3   1,20   4,53  3.1.2.1:1
                                            BAD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 7

    LITERAL OTHER     at 20, 3  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
              "              No, that's not it.  Try again.                     "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

    BRANCH TO 3.1.2.1:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 9

    BRANCH TO NEXT EVENT 3.1.2.1
```

```
Event Detail for Presentation ALIGN2      Event 3.1.2.1       11 of 23  Events

Time                                                                    Column

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

     STILL FRAME  6810 on Player 1

     GRAPHIC BKHLP            Wipe = Dissolve              Time =  0.0 seconds
                              Colors: Trans. = BLUE        Border = BLUE
                              FULL SCREEN     Mode = HI

     LITERAL 3121     at 20, 4  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                             " How do you reset the ABF function keypad?        "

     TOUCH 3121              Tch  Rows   Cols  Branch
                              #                Feedback
                              1  21,25  63,76  :HELP
                                               GOOD BEEP
                              2  21,25   5,18  3.1.1:1
                                               GOOD BEEP
                              3   3, 7  39,48  :REINF
                                               GOOD BEEP
                              4   3,19   4,52  :OTHER
                                               BAD BEEP

     BRANCH TO +1

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

     STILL FRAME  6810 on Player 1

     GRAPHIC X***Y***         Wipe = None
                              Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL           Mode = HI

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

     CLEARHI to BLUE with BLUE Border and BLUE Transparent

     CLEAR TOUCH

     BRANCH TO +1

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
    GRAPHIC X***Y***           Wipe = None
                               Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                               PANEL              Mode = HI

    LITERAL 3121A     at 20, 4  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                    " To reset the ABF function keypad, press the RESET key.

    TOUCH 3121A              Tch  Rows   Cols  Branch
                              #                Feedback
                              1   3, 7  39,48  3.1.2.2
                                               GOOD BEEP
                              2   3,19   1,52  :OTHER
                                               BAD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF #

    STILL FRAME  6810 on Player 1

    GRAPHIC CMD                Wipe = Dissolve                Time =  0.0 seconds
                               Rows = 15,19  Cols = 53,80.    Transcolor = BLUE
                               PANEL              Mode = HI

    LITERAL 3121R     at 20, 4  Colors: Before = LT GREEN on BLUE
                                        After  = LT GREEN on BLUE
            "         You're doing great!                                         "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - #

    BRANCH TO :CMD

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - CMD # 7

    STILL FRAME  6810 on Player 1

    GRAPHIC NEXT               Wipe = None
                               Colors: Trans. = BLUE          Border = BLUE
                               FULL SCREEN        Mode = HI

    CLEAR TOUCH

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

    GRAPHIC CMD                Wipe = Dissolve                Time =  0.0 seconds
                               Rows = 15,19  Cols = 53,80.    Transcolor = BLUE
                               PANEL              Mode = HI
```

```
     TOUCH 3121NXT             Tch  Rows    Cols  Branch
                                #                 Feedback
                                1   12,16   13,23 3.1.2.2:REINF
                                                  GOOD BEEP
                                3    3,19    1,52 :OTHER
                                                  BAD BEEP
                                2   21,25   63,76 3.1.2.2:1
                                                  GOOD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

     GRAPHIC X***Y***         Wipe = Dissolve            Time =  0.0 seconds
                              Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL            Mode = HI

     LITERAL OTHER    at 20, 3  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
               "              No, that's not it.  Try again.                  "

     BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

     BRANCH TO 3.1.2.1:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

     BRANCH TO NEXT EVENT 3.1.2.2
```

```
 Event Detail for Presentation ALIGN2     Event 3.1.2.2      12 of 23  Events

Time                                                                   Column

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

    STILL FRAME  6810 on Player 1

    GRAPHIC BKHLP             Wipe = None
                              Colors: Trans. = BLUE         Border = BLUE
                              FULL SCREEN       Mode = HI

    LITERAL 3122      at 20, 3  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                          " Which command will select the alignment procedures? "

    TOUCH 3122                 Tch  Rows    Cols  Branch
                                #                 Feedback
                                1  21,25   63,76  :HELP
                                                  GOOD BEEP
                                2  21,25    5,18  3.1.2.1:1
                                                  GOOD BEEP
                                3  12,16   13,23  :CMD05
                                                  GOOD BEEP
                                4   3,19    4,52  :OTHER
                                                  BAD BEEP

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

    STILL FRAME  6810 on Player 1

    GRAPHIC CMD               Wipe = None
                              Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL             Mode = HI

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

    CLEARHI to BLUE with BLUE Border and BLUE Transparent

    CLEAR TOUCH

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
     GRAPHIC CMD                 Wipe = None
                                 Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                                 PANEL             Mode = HI

     LITERAL 3122H    at 20, 3  Colors: Before = HI WHITE on BLACK
                                        After  = YELLOW on WHITE
           " Command 5 accesses the alignment procedures, press the "5" key. "

     TOUCH 3122A              Tch  Rows    Cols  Branch
                               #                 Feedback
                               1  12,16   13,23  3.1.2.3
                                                 GOOD BEEP
                               2   3,19    1,52  :OTHER
                                                 BAD BEEP

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 5

     STILL FRAME  6810 on Player 1

     GRAPHIC CMD05               Wipe = None
                                 Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                                 PANEL             Mode = HI

     LITERAL 3121R    at 20,10  Colors: Before = LT GREEN on BLUE
                                        After  = LT GREEN on BLUE
           "        You're doing great!                                          "

     BRANCH TO +1

  2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

     BRANCH TO :CMD05

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - CMD05 # 7

     STILL FRAME  6810 on Player 1

     GRAPHIC NEXT                Wipe = None
                                 Colors: Trans. = BLUE         Border = BLUE
                                 FULL SCREEN       Mode = HI

     CLEAR TOUCH

     BRANCH TO +1

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

     GRAPHIC CMD05               Wipe = None
                                 Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                                 PANEL             Mode = HI
```

```
    TOUCH 3122NXT           Tch  Rows   Cols  Branch
                             #     .          Feedback
                             1  15,20  39,49  3.1.2.3:REINF
                                              GOOD BEEP
                             3   3,19   1,52  :OTHER
                                              BAD BEEP
                             2  21,25  63,76  3.1.2.3:1
                                              GOOD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

    GRAPHIC CMD                 Wipe = None
                                Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                                PANEL               Mode = HI

    LITERAL OTHER     at 20, 3  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                 "              No, that's not it.  Try again.                     "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

    BRANCH TO 3.1.2.2:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

    BRANCH TO NEXT EVENT 3.1.2.3
```

```
Event Detail for Presentation ALIGN2     Event 3.1.2.3      13 of 23  Events

Time                                                                     Column

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

    STILL FRAME  6810 on Player 1

    GRAPHIC BKHLP             Wipe = None
                              Colors: Trans. = BLUE        Border = BLUE
                              FULL SCREEN      Mode = HI

    LITERAL 3123      at 20, 3  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
                     " How do you enter your selection?                       "

    TOUCH 3123               Tch  Rows    Cols   Branch
                              #                  Feedback
                              1   21,25   63,76  :HELP
                                                 GOOD BEEP
                              2   21,25    5,18  3.1.2.2:1
                                                 GOOD BEEP
                              3   15,20   39,49  :REINF
                                                 GOOD BEEP
                              4    3,19    4,52  :OTHER
                                                 BAD BEEP

    BRANCH TO +1

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

    STILL FRAME  6810 on Player 1

    GRAPHIC CMDOS             Wipe = None
                              Rows = 15,19  Cols = 53,80.  Transcolor = BLUE
                              PANEL             Mode = HI

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

    CLEARHI to BLUE with BLUE Border and BLUE Transparent

    CLEAR TOUCH

    BRANCH TO +1

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
    GRAPHIC CMD05              Wipe = None
                               Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                               PANEL             Mode = HI

    LITERAL 3123H    at 20, 4  Colors: Before = YELLOW on BLUE
                                       After  = YELLOW on BLUE
                         " Press the ENTER key to enter your selection.          "

    TOUCH 3123H              Tch  Rows   Cols  Branch
                              #                Feedback
                              1  15,20  39,49  3.1.2.4:1
                                               GOOD BEEP
                              2   3,19   1,52  :OTHER
                                               BAD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 5

    STILL FRAME  6810 on Player 1

    GRAPHIC ALNUM              Wipe = None
                               Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                               PANEL             Mode = HI

    LITERAL 3123R    at 20, 3  Colors: Before = LT GREEN on BLUE
                                       After  = LT GREEN on BLUE
           "                   Excellent!                                         "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

    BRANCH TO :ALNUM

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - ALNUM # 7

    STILL FRAME  6810 on Player 1

    GRAPHIC NEXT               Wipe = Dissolve                Time =  0.0 seconds
                               Colors: Trans. = BLUE          Border = BLUE
                               FULL SCREEN       Mode = HI

    CLEAR TOUCH

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

    GRAPHIC ALNUM              Wipe = None
                               Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                               PANEL             Mode = HI
```

```
TOUCH 3121NXT          Tch  Rows   Cols   Branch
                        #                 Feedback
                        1   15,19  22,31  3.1.2.4:REINF
                                          GOOD BEEP
                        3    3,19   1,52  :OTHER
                                          BAD BEEP
                        2   21,25  63,76  3.1.2.4:1
                                          GOOD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

GRAPHIC CMD05              Wipe = None
                           Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                           PANEL              Mode = HI

LITERAL OTHER     at 20, 3  Colors: Before = YELLOW on BLUE
                                    After  = YELLOW on BLUE
                "          No, that's not it.  Try again.                   "

BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

BRANCH TO 3.1.2.3:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

BRANCH TO NEXT EVENT 3.1.2.4
```

```
 Event Detail for Presentation ALIGN2     Event 3.1.2.4      14 of 23  Events

Time                                                                    Column

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

      STILL FRAME  6810 on Player 1

      GRAPHIC BKHLP               Wipe = Dissolve                Time =  0.0 seconds
                                  Colors: Trans. = BLUE          Border = BLUE
                                  FULL SCREEN       Mode = HI

      LITERAL 3124       at 20, 3  Colors: Before = YELLOW on BLUE
                                           After  = YELLOW on BLUE
                  "  Which key will allow adjustment of the 2nd alignment?         "

      TOUCH 3124                Tch  Rows    Cols   Branch
                                 #                  Feedback
                                 1  21,25   63,76   :HELP
                                                    GOOD BEEP
                                 2  21,25    5,18   3.1.2.3:1
                                                    GOOD BEEP
                                 3  15,20   22,32   :REINF
                                                    GOOD BEEP
                                 4   3,19    4,52   :OTHER
                                                    BAD BEEP

      BRANCH TO +1

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

      STILL FRAME  6810 on Player 1

      GRAPHIC ALNUM               Wipe = Dissolve                Time =  0.0 seconds
                                  Rows = 15,19  Cols = 53,80.    Transcolor = BLUE
                                  PANEL             Mode = HI

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

      CLEARHI to BLUE with BLUE Border and BLUE Transparent

      CLEAR TOUCH

      BRANCH TO +1

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
     GRAPHIC ALNUM              Wipe = Dissolve               Time =  0.0 seconds
                                Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                                PANEL               Mode = HI

     LITERAL 3124H     at 20, 3  Colors: Before = YELLOW on WHITE
                                         After  = YELLOW on WHITE
                    " To allow adjustment of the 2nd alignment, press the "2" key."

     TOUCH 3124H               Tch  Rows   Cols  Branch
                                #                Feedback
                                1  15,20  21,32  3.1.2.5:1
                                                 GOOD BEEP
                                2   3,19   1,52  :OTHER
                                                 BAD BEEP

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 5

     STILL FRAME  6810 on Player 1

     GRAPHIC X800Y800           Wipe = None
                                Rows = 12,19  Cols = 53,80.   Transcolor = BLUE
                                PANEL               Mode = HI

     LITERAL 3121R     at 20, 4  Colors: Before = LT GREEN on BLUE
                                         After  = LT GREEN on BLUE
                 "        You're doing great!                                     "

     BRANCH TO +1

 2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

     BRANCH TO :X***Y***

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -X***Y*** # 7

     STILL FRAME  6810 on Player 1

     GRAPHIC NEXT               Wipe = Dissolve               Time =  0.0 seconds
                                Colors: Trans. = BLUE         Border = BLUE
                                FULL SCREEN         Mode = HI

     CLEAR TOUCH

     BRANCH TO +1

 0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

     GRAPHIC X800Y800           Wipe = None
                                Rows = 12,19  Cols = 53,80.   Transcolor = BLUE
                                PANEL               Mode = HI
```

```
TOUCH 3124NXT          Tch  Rows   Cols  Branch
                        #                Feedback
                        1    3, 7  13,23 3.1.2.5:REINF
                                         GOOD BEEP
                        3    3,19   1,52 :OTHER
                                         BAD BEEP
                        2  21,25  63,76  3.1.2.5:1
                                         GOOD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

    GRAPHIC ALNUM              Wipe = Dissolve               Time =  0.0 seconds
                               Rows = 15,19  Cols = 53,80.   Transcolor = BLUE
                               PANEL            Mode = HI

    LITERAL OTHER     at 20,10  Colors: Before = HI WHITE on BLUE
                                        After  = HI WHITE on BLUE
              "                No, that's not it.  Try again.                   "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

    BRANCH TO 3.1.2.4:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

    BRANCH TO NEXT EVENT 3.1.2.5
```

```
Event Detail for Presentation ALIGN2     Event 3.1.2.5      15 of 23  Events

Time                                                                   Column

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

   STILL FRAME  6810 on Player 1

   GRAPHIC BKHLP            Wipe = Dissolve              Time =  0.0 seconds
                            Colors: Trans. = BLUE        Border = BLUE
                            FULL SCREEN      Mode = HI

   LITERAL 3125      at 20, 3  Colors: Before = YELLOW on BLUE
                                       After  = YELLOW on BLUE
          " Which key will cause a deflection in the +X direction?          "

   TOUCH 3125               Tch  Rows   Cols  Branch
                             #                Feedback
                             1  21,25  63,76  :HELP
                                              GOOD BEEP
                             2  21,25   5,18  3.1.2.4:1
                                              GOOD BEEP
                             3   2, 7  13,23  :REINF
                                              GOOD BEEP
                             4   3,19   4,52  :OTHER
                                              BAD BEEP

   BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

   STILL FRAME  6810 on Player 1

   GRAPHIC X800Y800         Wipe = Dissolve              Time =  0.0 seconds
                            Rows = 12,19  Cols = 53,80.  Transcolor = BLUE
                            PANEL            Mode = HI

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

   CLEARHI to BLUE with BLUE Border and BLUE Transparent

   CLEAR TOUCH

   BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
    GRAPHIC X800Y800          Wipe = Dissolve                Time =  0.0 seconds
                              Rows = 12,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL            Mode = HI

    LITERAL 3125H    at 20, 3  Colors: Before = YELLOW on BLUE
                                       After  = YELLOW on BLUE
           "  Press the "RIGHT ARROW" key to cause a +X deflection.

    TOUCH 3125H             Tch  Rows   Cols  Branch
                             #                Feedback
                             1    2, 7  13,23  :DEFL
                                              GOOD BEEP
                             2    3,19   1,52  :OTHER
                                              BAD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 5

    STILL FRAME  6810 on Player 1

    GRAPHIC X800Y800          Wipe = Dissolve                Time =  0.0 seconds
                              Rows = 12,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL            Mode = HI

    LITERAL 3121R    at 20, 4  Colors: Before = LT GREEN on BLUE
                                       After  = LT GREEN on BLUE
           "       You're doing great!                                         "

    BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

    BRANCH TO :DEFL

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -DEFL # 7

    STILL FRAME  6770 on Player 1

    GRAPHIC NEXT              Wipe = Dissolve                Time =  0.0 seconds
                              Colors: Trans. = BLUE         Border = BLUE
                              FULL SCREEN      Mode = HI

    CLEAR TOUCH

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

    GRAPHIC XA4DY800          Wipe = Dissolve                Time =  0.0 seconds
                              Rows = 12,19  Cols = 53,80.   Transcolor = BLUE
                              PANEL            Mode = HI
```

```
      Text POPUP a:3125txt.pop at  1, 1;11,26. Color is HI WHITE on BLUE

      TOUCH 3125NXT           Tch  Rows   Cols  Branch
                               #                Feedback
                               1  21,25  63,76  3.1.2:1
                                                GOOD BEEP

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

      GRAPHIC X800Y800          Wipe = Dissolve              Time =  0.0 seconds
                                Rows = 12,19  Cols = 53,80.  Transcolor = BLUE
                                PANEL            Mode = HI

      LITERAL OTHER     at 20,10  Colors: Before = HI WHITE on BLUE
                                          After  = HI WHITE on BLUE
                  "             No, that's not it.  Try again.                  "

      BRANCH TO +1

  2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

      BRANCH TO 3.1.2.5:1

  0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

      BRANCH TO NEXT EVENT 3.1.2
```

```
Time                                                                    Columr

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 1

    STILL FRAME  6810 on Player 1

    GRAPHIC BKHLP              Wipe = Dissolve                Time =  0.0 seconds
                               Colors: Trans. = BLUE          Border = BLUE
                               FULL SCREEN      Mode = HI

    LITERAL 312       at 20, 7  Colors: Before = YELLOW on BLUE
                                        After  = YELLOW on BLUE
              " The beam is only half deflected, keep going!                  "

    TOUCH 312                Tch  Rows   Cols  Branch
                              #                Feedback
                              1  21,25  63,76  :HELP
                                               GOOD BEEP
                              2  21,25   5,18  3.1.2.5:1
                                               GOOD BEEP
                              3   2, 7  13,23  :REINF
                                               GOOD BEEP
                              4   3,19   4,52  :OTHER
                                               BAD BEEP

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 2

    STILL FRAME  6810 on Player 1

    GRAPHIC XA4DY800           Wipe = Dissolve                Time =  0.0 seconds
                               Rows = 12,19  Cols = 53,80.    Transcolor = BLUE
                               PANEL            Mode = HI

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -HELP # 3

    CLEARHI to BLUE with BLUE Border and BLUE Transparent

    CLEAR TOUCH

    BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 4
```

```
GRAPHIC XA4DY800          Wipe = Dissolve                Time =  0.0 seconds
                          Rows = 12,19  Cols = 53,80.    Transcolor = BLUE
                          PANEL             Mode = HI

LITERAL 312H     at 20, 4  Colors: Before = YELLOW on BLUE
                                   After  = YELLOW on BLUE
          " You must continue to press the RIGHT ARROW key.                "

TOUCH 3125H             Tch  Rows   Cols  Branch
                         #                Feedback
                         1   2, 7  13,23  :DEFL
                                          GOOD BEEP
                         2   3,19   1,52  :OTHER
                                          BAD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - REINF # 5

STILL FRAME  6810 on Player 1

GRAPHIC XA4DY800          Wipe = Dissolve                Time =  0.0 seconds
                          Rows = 12,19  Cols = 53,80.    Transcolor = BLUE
                          PANEL             Mode = HI

LITERAL 3121R    at 20, 4  Colors: Before = LT GREEN on BLUE
                                   After  = LT GREEN on BLUE
          "       You're doing great!                                      "

BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 6

BRANCH TO :DEFL

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -DEFL # 7

STILL FRAME  6774 on Player 1

GRAPHIC NEXT              Wipe = Dissolve                Time =  0.0 seconds
                          Colors: Trans. = BLUE          Border = BLUE
                          FULL SCREEN       Mode = HI

CLEAR TOUCH

BRANCH TO +1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 8

GRAPHIC XF7FY800          Wipe = Dissolve                Time =  0.0 seconds
                          Rows =  8,15  Cols = 53,80.    Transcolor = BLUE
                          PANEL             Mode = HI
```

```
Text POPUP a:312txt.pop at  1, 1;12,30. Color is HI WHITE on BLUE

TOUCH 312NXT          Tch  Rows   Cols  Branch
                       #                Feedback
                       1  21,25  63,76  3.2.2.1:1
                                        GOOD BEEP

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - OTHER # 9

GRAPHIC XA4DY800        Wipe = Dissolve              Time =  0.0 seconds
                        Rows = 12,19  Cols = 53,80.  Transcolor = BLUE
                        PANEL            Mode = HI

LITERAL OTHER    at 20,10  Colors: Before = HI WHITE on BLUE
                                   After  = HI WHITE on BLUE
            "           No, that's not it.  Try again.                     "

BRANCH TO +1

2.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 10

BRANCH TO 3.1.2:1

0.0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - # 11

BRANCH TO NEXT EVENT 3.2.2.1
```

SUMMARY OF SELECTED EVENTS

8 of 23 events in the presentation were selected.

USEAGE OF COMMANDS.

COMMAND	# TIMES USED	IN # EVENTS
Begin Segment	0	0
Match Segment	0	0
Still Frame	26	8
Still Frame Audio	0	0
Portfolio	0	0
Load Player	0	0
Unload Player	0	0
Graph	46	8
CLEAR	7	7
Interlace Control	0	0
Display Literal	29	8
Display Pop Up	4	3
Display Variable	0	0
Touch	24	8
Clear Touch	12	6
User Control	0	0
Sound	0	0
Match Phrase	0	0
Variable Input	0	0
Addition	0	0
Subtraction	0	0
Multiplication	0	0
Division	0	0
Exponentiation	0	0
Set Variable(s)	0	0
Set Indicators	0	0
Test Indicators	0	0
Add Indicators	0	0
Log On	0	0
Log Off	0	0
Branch	46	7
User Procedure	0	0
TSR User Exit	0	0

```
EVENTS THAT WERE USED

Event INTRO    is the Starting Event and is not referred to by another event.
Event 3.1.1    was referred to   1 time by the following events:
     3.0
Event 3.1.2.1  was referred to   1 time by the following events:
     3.1.1
Event 3.1.2.2  was referred to   2 times by the following events:
     3.1.2.1
Event 3.1.2.3  was referred to   2 times by the following events:
     3.1.2.2
Event 3.1.2.4  was referred to   1 time by the following events:
     3.1.2.3
Event 3.1.2.5  was referred to   1 time by the following events:
     3.1.2.4

ALL EVENTS REFERENCED WERE FOUND IN THE PRESENTATION


EVENTS THAT WERE NOT USED

     LESSON1A LESSON1B XYZTEST  LESSON1C LESSON1D LESSON2A LESSON2B 3.0
     3.1.2    3.2.2.1  4.0      3.2.1.2  3.2.2.3  3.2.2    3.3.2.1  EXIT
```

```
GRAPHS THAT WERE USED

Graph ALNUM    was referred to   5 times by the following events:
     3.1.2.3  3.1.2.4
Graph BKHLP    was referred to   7 times by the following events:
     3.1.1    3.1.2.1  3.1.2.2  3.1.2.3  3.1.2.4  3.1.2.5  3.1.2
Graph BKNXT    was referred to   2 times by the following events:
     3.0
Graph CMD      was referred to   5 times by the following events:
     3.1.2.1  3.1.2.2
Graph CMD05    was referred to   5 times by the following events:
     3.1.2.2  3.1.2.3
Graph NEXT     was referred to   7 times by the following events:
     3.1.1    3.1.2.1  3.1.2.2  3.1.2.3  3.1.2.4  3.1.2.5  3.1.2
Graph X***Y*** was referred to   3 times by the following events:
     3.1.2.1
Graph X800Y800 was referred to   6 times by the following events:
     3.1.2.4  3.1.2.5
Graph XA4DY800 was referred to   5 times by the following events:
     3.1.2.5  3.1.2
Graph XF7FY800 was referred to   1 time by the following events:
     3.1.2


ALL GRAPHS REFERENCED WERE FOUND IN THE PRESENTATION



GRAPHS THAT WERE NOT USED

     4BOXES   BACK     BACKGRN  BKNXTGRN BOBMENU  BOBMENU2 CMD03    CMD04
     CMD06    DETAIL40 DETAIL80 DETAILHH DETAILHI DETAILLO DETAILMD DITH3C
     DVM0018  DVM1162  DVM2446  EBL      HELLO    HELLO2   HELP40   HELP80
     HELPHH   HELPHI   HELPLO   HELPMD   HEX0     HEX1     HEX2     HEX3
     HEX4     HEX5     HEX6     HEX7     HEX8     HEX9     HEXA     HEXB
     HEXC     HEXD     HEXE     HEXF     HEXPANLS HEXX     HEXY     INPUT40
     INPUT80  INPUTHH  INPUTHI  INPUTLO  INPUTMD  MNBKNXT  NEXT40   NEXT80
     NEXTHH   NEXTHI   NEXTLO   NEXTMD   PROFILE  REPLAY40 REPLAY80 REPLAYHH
     REPLAYHI REPLAYLO REPLAYMD RESUME40 RESUME80 RESUMEHH RESUMEHI RESUMELO
     RESUMEMD RETURN40 RETURN80 RETURNHH RETURNHI RETURNLO RETURNMD SLOWB40
     SLOWB80  SLOWBHH  SLOWBHI  SLOWBLO  SLOWBMD  SLOWF40  SLOWF80  SLOWFHH
     SLOWFHI  SLOWFLO  SLOWFMD  STANDARD STDBOXS  STOP40   STOP80   STOPHH
     STOPHI   STOPLO   STOPMD   SYSTEM40 SYSTEM80 SYSTEMHH SYSTEMHI SYSTEMLO
     SYSTEMMD TCHBOX   TEST     VDISC80  X/1Y/0   X9F7Y800 XYZTEST
```

```
VARIABLES THAT WERE USED

NONE USED

ALL VARIABLES REFERENCED WERE FOUND IN THE PRESENTATION


VARIABLES THAT WERE NOT USED

    $XDECR   $XINCR   %T0      %T1      %T10     %T11     %T12     %T13
    %T14     %T15     %T16     %T17     %T18     %T19     %T2      %T20
    %T21     %T22     %T23     %T24     %T25     %T26     %T27     %T28
    %T29     %T3      %T30     %T31     %T32     %T33     %T34     %T35
    %T36     %T37     %T38     %T39     %T4      %T40     %T41     %T42
    %T43     %T44     %T45     %T46     %T47     %T48     %T49     %T5
    %T50     %T51     %T52     %T53     %T54     %T55     %T56     %T57
    %T58     %T59     %T6      %T60     %T7      %T8      %T9
```

This file contains the text for all the popup literals that appear in the training module. The filename and extension for each popup is given.

3OBJTXT.POP

The objective of this lesson is: Set the Beam to One Side of the 2nd Aperture.

To do this, you MAXIMIZE the 2nd Aperture reading on the DVM.

When this lesson is completed, you will be able to use the Alignment Brightness FRU keypad to steer the beam off-center and maximize the DVM reading.

Touch NEXT for directions how to use the simulation.

3DIRTXT.POP

Directions for Using the Simulation.

Touch the key that you think is appropriate for each step and simply follow the prompts.

Since you can't turn a switch on the screen, just touch it to acknowledge that you wanted to.

Touch NEXT if you need a hint for the next step.

Touch HELP if you need to be shown the next step.

Touch BACK to return to the previous step.

Touch NEXT at this time to begin the lesson.

311TXT.POP

Touch the Meter Select Switch to simulate setting it to the 2A position.

3125TXT.POP

The beam is only half deflected at this point.

The DVM reading is increasing, but it is not maximized yet.

Touch NEXT to return to the keypad.

312TXT.POP

The beam is fully defelected to one side and the DVM reading is at a maximum.

All of the beam is striking the plate. None of the beam is passing through the 2nd Aperture.

Touch NEXT to continue.

APPENDIX I

EDIT DECISION LIST

FINAL DISCS

```
EDIT LIST FILE : b:eblver2b.e                                    11/09/89

EVENT  RECD--START  RECD---STOP      SG -0-   COLOR BARS
  1     0: 1: 0: 0   0: 3: 0: 0 TC   SS -0-   (LEADER FOR DISC MASTERING)
            -5399          -1800 FM

EVENT  RECD--START  RECD---STOP      SG -0-   4-2-3    BOTH RISE + FALL
  2     0: 4: 1: 0   0: 4:19:12 TC   SS -0-
               31            582 FM

EVENT  RECD--START  RECD---STOP      SG -0-   4-2-4    ONE RISE/ONE FALL
  3     0: 4:19:12   0: 4:37:10 TC   SS -0-
              583           1120 FM

EVENT  RECD--START  RECD---STOP      SG -0-   4-2-2.   GOOD WAVEFORM
  4     0: 4:37:10   0: 4:56: 2 TC   SS -0-
             1121           1682 FM

EVENT  RECD--START  RECD---STOP      SG -0-   5-3-2    2ND APERTURE
  5     0: 4:56: 2   0: 5: 8:22 TC   SS -0-                 ROTATION ADJUST
             1683           2062 FM

EVENT  RECD--START  RECD---STOP      SG -0-   5.5.2    UPPER SHAPING ROTATION
  6     0: 5: 8:22   0: 5:48:14 TC   SS -0-
             2063           3254 FM

EVENT  RECD--START  RECD---STOP      SG -0-
  7     0: 5:48:15   0: 6:13: 0 TC   SS -0-
             3255           3990 FM

EVENT  RECD--START  RECD---STOP      SG -0-
  8     0: 6:13: 0   0: 6:32:26 TC   SS -0-      5-6-1-3
             3991           4586 FM

EVENT  RECD--START  RECD---STOP      SG -0-
  9     0: 6:32:26   0: 6:38: 2 TC   SS -0-      5-6-2
             4587           4742 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 10     0: 6:38: 2   0: 6:54:18 TC   SS -0-
             4743           5238 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 11     0: 6:54:18   0: 6:59:14 TC   SS -0-
             5239           5384 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 12     0: 6:59:14   0: 7:19:10 TC   SS -0-
             5385           5980 FM

EVENT  RECD--START  RECD---STOP      SG -0-   3 WAY SPLIT
 13     0: 7:19:10   0: 7:39:10 TC   SS -0-
             5981           6580 FM

EVENT  RECD--START  RECD---STOP      SG -0-   COLUMN + TABLE (LONG);
 14     0: 7:39:11   0: 7:39:14 TC   SS -0-   ↑ 3000
             6581           6584 FM
```

EDIT LIST FILE : b:eblver2b.e 11/09/89

```
EVENT  RECD--START  RECD---STOP      SG -0-
  15    0: 7:39:14   0: 7:39:18 TC  SS -0-
              6585         6588 FM
```

COLUMN + TABLE (MED)
A 3001

```
EVENT  RECD--START  RECD---STOP      SG -0-
  16    0: 7:39:18   0: 7:39:22 TC  SS -0-
              6589         6592 FM
```

"Y" MANUAL DRIVE
A 3002

```
EVENT  RECD--START  RECD---STOP      SG -0-
  17    0: 7:39:22   0: 7:39:26 TC  SS -0-
              6593         6596 FM
```

COLUMN BASE M C/U
A 3003

```
EVENT  RECD--START  RECD---STOP      SG -0-
  18    0: 7:39:26   0: 7:40: 0 TC  SS -0-
              6597         6600 FM
```

COLUMN BASE C/U
A 3004

```
EVENT  RECD--START  RECD---STOP      SG -0-
  19    0: 7:40: 0   0: 7:40: 4 TC  SS -0-
              6601         6604 FM
```

CREAM BOX + COLUMN M C/U
A 3005

```
EVENT  RECD--START  RECD---STOP      SG -0-
  20    0: 7:40: 4   0: 7:40: 8 TC  SS -0-
              6605         6608 FM
```

CREAM BOX + COLUMN C/U
A 3006

```
EVENT  RECD--START  RECD---STOP      SG -0-
  21    0: 7:40: 8   0: 7:40:12 TC  SS -0-
              6609         6612 FM
```

UPPER CREAM BOX C/U
A 3007

```
EVENT  RECD--START  RECD---STOP      SG -0-
  22    0: 7:40:12   0: 7:40:16 TC  SS -0-
              6613         6616 FM
```

LOWER CREAM BOX C/U
A 3008

```
EVENT  RECD--START  RECD---STOP      SG -0-
  23    0: 7:40:16   0: 7:40:20 TC  SS -0-
              6617         6620 FM
```

"X" MANUAL DRIVE
A 3009

```
EVENT  RECD--START  RECD---STOP      SG -0-
  24    0: 7:40:20   0: 7:40:24 TC  SS -0-
              6621         6624 FM
```

TABLE (FROM LEFT) M C/U
A 3010

```
EVENT  RECD--START  RECD---STOP      SG -0-
  25    0: 7:40:24   0: 7:40:28 TC  SS -0-
              6625         6628 FM
```

TABLE + COLUMN (LEFT)
A 3011

```
EVENT  RECD--START  RECD---STOP      SG -0-
  26    0: 7:40:28   0: 7:41: 2 TC  SS -0-
              6629         6632 FM
```

TOP OF COLUMN (LEFT) M C/U
A 3012

```
EVENT  RECD--START  RECD---STOP      SG -0-
  27    0: 7:41: 2   0: 7:41: 6 TC  SS -0-
              6633         6636 FM
```

TOP OF COLUMN (LEFT) C/U
A 3013

```
EVENT  RECD--START  RECD---STOP      SG -0-
  28    0: 7:41: 6   0: 7:41:10 TC  SS -0-
              6637         6640 FM
```

DOME BOOSTERS (LEFT) C/U
A 3014

```
EDIT LIST FILE : b:eblver2b.e                                        11/09/89

EVENT  RECD--START  RECD---STOP      SG -0-   COLUMN BASE (LEFT/FRONT) C/U
 29     0: 7:41:10   0: 7:41:14 TC.  SS -0-       A 3015
              6641         6644 FM

EVENT  RECD--START  RECD---STOP      SG -0-   TABLE + COLUMN (FRONT)
 30     0: 7:41:14   0: 7:41:18 TC   SS -0-      A 3016
              6645         6648 FM

EVENT  RECD--START  RECD---STOP      SG -0-   COLUMN (RIGHT)
 31     0: 7:41:18   0: 7:41:22 TC   SS -0-      A 3017
              6649         6652 FM

EVENT  RECD--START  RECD---STOP      SG -0-                 (RIGHT)
 32     0: 7:41:22   0: 7:41:26 TC   SS -0-
              6653         6656 FM                A 3018

EVENT  RECD--START  RECD---STOP      SG -0-   FILAMENT CHANGER  C/U
 33     0: 7:41:26   0: 7:42: 0 TC   SS -0-      A 3019
              6657         6660 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 34     0: 7:42: 0   0: 7:42: 4 TC   SS -0-
              6661         6664 FM                               A 3021

EVENT  RECD--START  RECD---STOP      SG -0-
 35     0: 7:42: 4   0: 7:42: 8 TC   SS -0-                 CARD
              6665         6668 FM           (CREAM BOX) EXTENDED   A 3025

EVENT  RECD--START  RECD---STOP      SG -0-
 36     0: 7:42: 8   0: 7:42:12 TC   SS -0-                 CARD EXTENDED
              6669         6672 FM                    A 3026

EVENT  RECD--START  RECD---STOP      SG -0-   SSM ADJUST/CARD  C/U
 37     0: 7:42:12   0: 7:42:16 TC   SS -0-     A 3027
              6673         6676 FM

EVENT  RECD--START  RECD---STOP      SG -0-   SSM ADJUST/CARD C/U
 38     0: 7:42:16   0: 7:42:20 TC   SS -0-       A 3028
              6677         6680 FM

EVENT  RECD--START  RECD---STOP      SG -0-   ABF TARGET ADJUST  C/U
 39     0: 7:42:20   0: 7:42:24 TC   SS -0-     A 3030
              6681         6684 FM

EVENT  RECD--START  RECD---STOP      SG -0-   ALIGNMENT BRIGHTNESS FRM
 55     0: 7:42:24   0: 7:42:28 TC   SS -0-          (OLD)
              6685         6688 FM

EVENT  RECD--START  RECD---STOP      SG -0-   DYNAMIC CORRECTIONS FRM
 40     0: 7:42:28   0: 7:43: 2 TC   SS -0-       (NEW)
              6689         6692 FM

EVENT  RECD--START  RECD---STOP      SG -0-   LENS   SUPPLY
 41     0: 7:43: 2   0: 7:43: 5 TC   SS -0-
              6693         6695 FM
```

```
EDIT LIST FILE : b:eblver2b.e                                11/09/89

EVENT  RECD--START  RECD---STOP       SG -0-  COLUMN W/LABELS
 42     0: 7:43: 6   0: 7:43:10 TC    SS -0-
             6697          6700 FM

EVENT  RECD--START  RECD---STOP       SG -0-  COLUMN W/O LABELS
 43     0: 7:43:10   0: 7:43:14 TC    SS -0-
             6701          6704 FM

EVENT  RECD--START  RECD---STOP       SG -0-  RACK ELEVATION
 44     0: 7:43:14   0: 7:43:18 TC    SS -0-
             6705          6708 FM

EVENT  RECD--START  RECD---STOP       SG -0-  SSM CARD (GRAPHIC)
 56     0: 7:43:18   0: 7:43:22 TC    SS -0-
             6709          6712 FM

EVENT  RECD--START  RECD---STOP       SG -0-  DYNAMIC CORRECTIONS FRY
 57     0: 7:43:22   0: 7:43:26 TC    SS -0-      (INSIDE)
             6713          6716 FM

EVENT  RECD--START  RECD---STOP       SG -0-  HIGH VOLTAGE CONTROL
 45     0: 7:43:26   0: 7:44: 0 TC    SS -0-      (OLD)
             6717          6720 FM

EVENT  RECD--START  RECD---STOP       SG -0-  SUBFIELD POSITION + TIMING
 46     0: 7:44: 0   0: 7:44: 4 TC    SS -0-      (OLD)
             6721          6724 FM

EVENT  RECD--START  RECD---STOP       SG -0-  ANALOG FEEDBACK FRY
 58     0: 7:44: 4   0: 7:44: 8 TC    SS -0-
             6725          6728 FM

EVENT  RECD--START  RECD---STOP       SG -0-  HV SUPPLY
 59     0: 7:44: 8   0: 7:44:12 TC    SS -0-
             6729          6732 FM

EVENT  RECD--START  RECD---STOP       SG -0-  RECTANGLE GENERATOR
 47     0: 7:44:12   0: 7:44:16 TC    SS -0-
             6733          6736 FM

EVENT  RECD--START  RECD---STOP       SG -0-  XY LOGIC FRY
 48     0: 7:44:16   0: 7:44:20 TC    SS -0-
             6737          6740 FM

EVENT  RECD--START  RECD---STOP       SG -0-  MANUAL CONTROL BOX
 49     0: 7:44:20   0: 7:44:24 TC    SS -0-
             6741          6744 FM

EVENT  RECD--START  RECD---STOP       SG -0-  SSM CONTROLS (NEW
 50     0: 7:44:24   0: 7:44:28 TC    SS -0-
             6745          6748 FM

EVENT  RECD--START  RECD---STOP       SG -0-  FILAMENT PROFILE
 51     0: 7:44:28   0: 7:45: 2 TC    SS -0-       GOOD
             6749          6752 FM
```

```
EDIT LIST FILE : b:eblver2b.e
                                                                 11/09/89

EVENT  RECD--START  RECD---STOP      SG -0-  FILAMENT PROFILE (BAD 1)
 52     0: 7:45: 2   0: 7:45: 6 TC   SS -0-
             6753           6756 FM

EVENT  RECD--START  RECD---STOP      SG -0-  FILAMENT PROFILE (BAD 2)
 53     0: 7:45: 6   0: 7:45:10 TC   SS -0-
             6757           6760 FM

EVENT  RECD--START  RECD---STOP      SG -0-  FILAMENT PROFILE (BAD 3)
 54     0: 7:45:10   0: 7:45:14 TC   SS -0-
             6761           6764 FM

EVENT  RECD--START  RECD---STOP      SG -0-  ALIGNMENT GRAPHIC (GOOD)
 60     0: 7:45:14   0: 7:45:18 TC   SS -0-
             6765           6768 FM

EVENT  RECD--START  RECD---STOP      SG -0-  ALIGNMENT GRAPHIC (X OUT)
 61     0: 7:45:18   0: 7:45:22 TC   SS -0-
             6769           6772 FM

EVENT  RECD--START  RECD---STOP      SG -0-  ALIGNMENT GRAPHIC (X ONE SI
 62     0: 7:45:22   0: 7:45:26 TC   SS -0-
             6773           6776 FM

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES
 63     0: 7:45:26   0: 7:46: 0 TC   SS -0-    4.1.1 - 4.1.3
             6777           6780 FM

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES
 64     0: 7:46: 0   0: 7:46: 4 TC   SS -0-
             6781           6784 FM            5.2.1

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES
 65     0: 7:46: 4   0: 7:46: 8 TC   SS -0-
             6785           6788 FM            5.8.1

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES
 66     0: 7:46: 8   0: 7:46:12 TC   SS -0-
             6789           6792 FM            2.2

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES
 67     0: 7:46:12   0: 7:46:16 TC   SS -0-
             6793           6796 FM            8.1

EVENT  RECD--START  RECD---STOP      SG -0-  SSM SWITCHES L SCAN
 68     0: 7:46:16   0: 7:46:20 TC   SS -0-    8.12
             6797           6800 FM

EVENT  RECD--START  RECD---STOP      SG -0-  ABF SERVOS  SERVO ON
 69     0: 7:46:20   0: 7:46:24 TC   SS -0-
             6801           6804 FM            3.7

EVENT  RECD--START  RECD---STOP      SG -0-  ABF SWITCHES
 70     0: 7:46:24   0: 7:46:28 TC   SS -0-
             6805           6808 FM          TGT/RST  1A
```

```
EDIT LIST FILE : b:eblver2b.e                                          11/09/89

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 71      0: 7:46:28    0: 7:47: 2 TC     SS -0-   TGT/RST 2A
              6809          6812 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 72      0: 7:47: 2    0: 7:47: 6 TC     SS -0-   SA/RST SA
              6813          6816 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 73      0: 7:47: 6    0: 7:47:10 TC     SS -0-   BLANK
              6817          6820 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SERVOS (ALL DOWN)
 74      0: 7:47:10    0: 7:47:14 TC     SS -0-
              6821          6824 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SERVOS (ALL UP)
 75      0: 7:47:14    0: 7:47:18 TC     SS -0-
              6825          6828 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 76      0: 7:47:18    0: 7:47:22 TC     SS -0-   TGT/RST 3A
              6829          6832 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 77      0: 7:47:22    0: 7:47:26 TC     SS -0-   TGT/RST SA
              6833          6836 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 78      0: 7:47:26    0: 7:48: 0 TC     SS -0-   TGT/RST BR
              6837          6840 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 79      0: 7:48: 0    0: 7:48: 4 TC     SS -0-   TGT/RST BR CTL
              6841          6844 FM

EVENT   RECD--START   RECD---STOP        SG -0-   ABF SWITCHES
 80      0: 7:48: 4    0: 7:48: 8 TC     SS -0-   TGT/RST FL
              6845          6848 FM

EVENT   RECD--START   RECD---STOP        SG -0-   SPAT 0010
 81      0: 7:48: 8    0: 7:48:12 TC     SS -0-
              6849          6852 FM

EVENT   RECD--START   RECD---STOP        SG -0-   SPAT 0020
 82      0: 7:48:12    0: 7:48:16 TC     SS -0-
              6853          6856 FM

EVENT   RECD--START   RECD---STOP        SG -0-   SPAT 0030
 83      0: 7:48:16    0: 7:48:20 TC     SS -0-
              6857          6860 FM

EVENT   RECD--START   RECD---STOP        SG -0-   SPAT 0040
 84      0: 7:48:20    0: 7:48:24 TC     SS -0-
              6861          6864 FM
```

```
EDIT LIST FILE : b:eblver2b.e                                  11/09/89

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF 0050
 85     0: 7:48:24   0: 7:48:28 TC  SS -0-
              6865          6868 FM

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF 0060
 86     0: 7:48:28   0: 7:49: 2 TC  SS -0-
              6869          6872 FM

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF 0070
 87     0: 7:49: 2   0: 7:49: 6 TC  SS -0-
              6873          6876 FM

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF 0080
 88     0: 7:49: 6   0: 7:49:10 TC  SS -0-
              6877          6880 FM

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF 0000
 89     0: 7:49:10   0: 7:49:14 TC  SS -0-
              6881          6884 FM

EVENT  RECD--START  RECD---STOP     SG -0-   MANUAL CONTROL BOX (NEW)
 90     0: 7:49:14   0: 7:49:18 TC  SS -0-
              6885          6888 FM

EVENT  RECD--START  RECD---STOP     SG -0-   SPAF DISPLAYS (TOP)
 91     0: 7:49:18   0: 7:49:22 TC  SS -0-
              6889          6892 FM

EVENT  RECD--START  RECD---STOP     SG -0-   HV CONTROL
 92     0: 7:49:22   0: 7:49:26 TC  SS -0-
              6893          6896 FM

EVENT  RECD--START  RECD---STOP     SG -0-   DYNAMIC CORRECTIONS FRY
 93     0: 7:49:26   0: 7:50: 0 TC  SS -0-
              6897          6900 FM

EVENT  RECD--START  RECD---STOP     SG -0-   LENS  SUPPLY  COND 1
 94     0: 7:50: 0   0: 7:50: 4 TC  SS -0-
              6901          6904 FM

EVENT  RECD--START  RECD---STOP     SG -0-   LENS  SUPPLY  COND 2
 95     0: 7:50: 4   0: 7:50: 8 TC  SS -0-
              6905          6908 FM

EVENT  RECD--START  RECD---STOP     SG -0-   LENS  SUPPLY  STIG 1
 96     0: 7:50: 8   0: 7:50:12 TC  SS -0-
              6909          6912 FM

EVENT  RECD--START  RECD---STOP     SG -0-   LENS  SUPPLY  STIG 2
 97     0: 7:50:12   0: 7:50:16 TC  SS -0-
              6913          6916 FM

EVENT  RECD--START  RECD--*STOP     SG -0-   LENS  SUPPLY  DEMAG 1
 98     0: 7:50:16   0: 7:50:20 TC  SS -0-
              6917          6920 FM
```

```
EDIT LIST FILE : b:eblver2b.e
                                                                11/09/99

EVENT   RECD--START   RECD---STOP      SG -0-   LENS SUPPLY DEMAG 2
  99     0: 7:50:20    0: 7:50:24 TC   SS -0-
              6921          6924 FM

EVENT   RECD--START   RECD---STOP      SG -0-   LENS SUPPLY PROS
 100     0: 7:50:24    0: 7:50:28 TC   SS -0-
              6925          6928 FM

EVENT   RECD--START   RECD---STOP      SG -0-   — BLANK —
 101     0: 7:50:28    0: 7:51: 2 TC   SS -0-
              6929          6932 FM

EVENT   RECD--START   RECD---STOP      SG -0-   DICTIONARY
 102     0: 7:51: 2    0: 7:51: 6 TC   SS -0-
              6933          6936 FM

EVENT   RECD--START   RECD---STOP      SG -0-
 103     0: 8: 0: 0    0: 8: 1:12 TC   SS -0-   X→Y, Y→X SSM
              7201          7242 FM

EVENT   RECD--START   RECD---STOP      SG -0-   SHAPING, FOCUS, STIG. X+Y
 104     0: 8: 1:12    0: 9:46:10 TC   SS -0-
              7243         10390 FM

EVENT   RECD--START   RECD---STOP      SG -0-   DYNAMIC CORRECTIONS
 105     0: 9:46:10    0:13:22:22 TC   SS -0-
             10391         16882 FM

EVENT   RECD--START   RECD---STOP      SG -0-
 106     0:13:22:22    0:13:47:18 TC   SS -0-
             16883         17628 FM

EVENT   RECD--START   RECD---STOP      SG -0-         CAL (O'SCOPE)
 107     0:13:47:18    0:14:50: 2 TC   SS -0-
             17629         19502 FM

EVENT   RECD--START   RECD---STOP      SG -0-
 108     0:14:50: 2    0:16: 0:16 TC   SS -0-
             19503         21616 FM

EVENT   RECD--START   RECD---STOP      SG -0-
 109     0:16: 0:16    0:17:34:14 TC   SS -0-
             21617         24434 FM

EVENT   RECD--START   RECD---STOP      SG -0-   L SCAN
 110     0:17:34:14    0:17:46:18 TC   SS -0-
             24435         24798 FM

EVENT   RECD--START   RECD---STOP      SG -0-
 111     0:17:46:18    0:18: 8:22 TC   SS -0-
             24799         25462 FM

EVENT   RECD--START   RECD---STOP      SG -0-   EL-3 ANIMATION
 112     0:18: 8:22    [illegible] TC   SS -0-
             25463         [illegible] FM
```

```
EDIT LIST FILE : b:eb1ver2b.e                                    11/07/89

EVENT  RECD--START  RECD---STOP      SG -0-
 113    0:18:33:22   0:18:38:14 TC  SS -0-
             26213        26354 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 114    0:18:38:14   0:18:50:24 TC  SS -0-
             26355        26724 FM

EVENT  RECD--START  RECD---STOP      SG -0-
 115    0:18:50:24   0:18:53:28 TC  SS -0-
             26725        26818 FM
```

APPENDIX J

COURSEWARE LOCATOR SHEET

The courseware (instructional software and videodisc) that was produced in the development phase of this project is available at the office of the graduate program in Master of Science in Training and Learning Technology, Old Westbury, N.Y., 11568. It can also be obtained through the Grumman Corporation, Electronics Systems Division, Simulation/Trainer Products Group, Bethpage. N.Y.

APPENDIX K

USERS' GUIDE

DIRECTIONS FOR OPERATION

1. Turn power on to equipment in the following order:
   Videodisc player, Computer, Display Monitor.
   - The speech synthesis module will say "O.K."
   - A batch file will load all appropriate software.

2. Touch the screen at the prompt to initialize the videodisc player.
   - The screen will display an animated movie "clapboard" that says "Interpreter," this is normal.
   - You will hear the videodisc player drawer open and close, this is normal.

3. When the system is ready, "EL-3" will appear on the screen. Touch the screen to proceed from there.
   - A series of animations and video will be displayed. It will stop at the MAIN MENU.

4. Gray boxes are Touch Sensitive Areas. To select a procedure to perform, touch the box next to the step.

5. Directions will appear at the bottom of the screen to assist in getting from one screen to another.

6. If you need help finding the location of a component, switch or adjustment, touch the HELP box in the upper left-hand corner. A menu will appear. Touch the name of what you want to see.

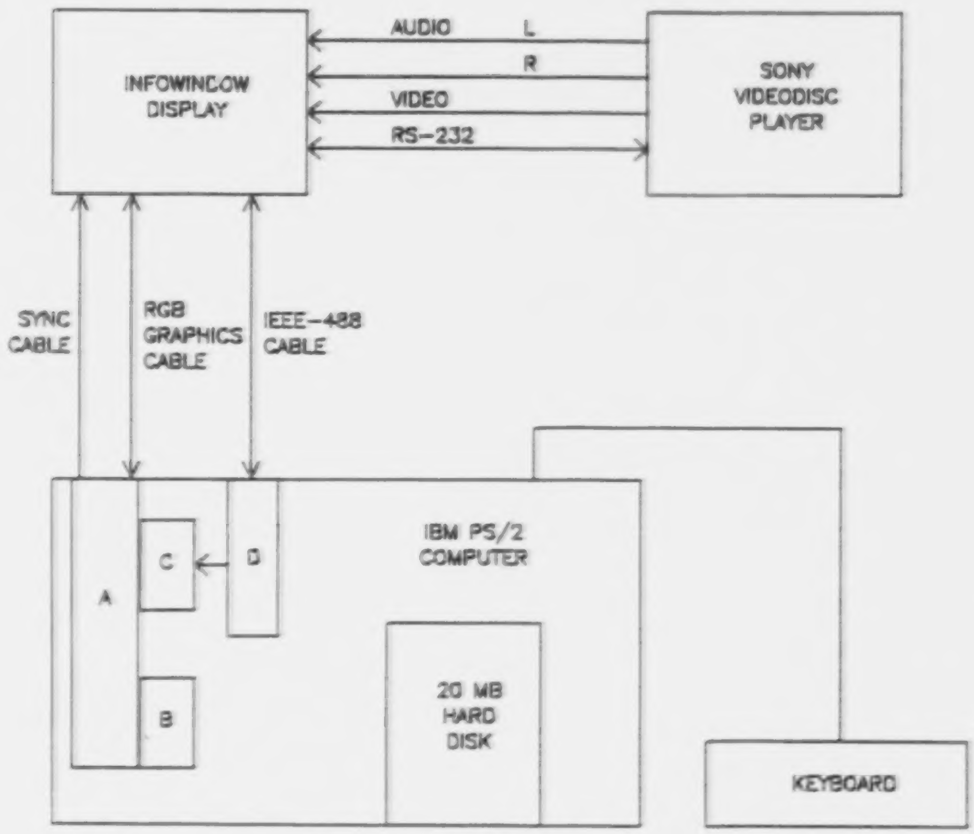
7. In case of problems:

   - Use "Alt F10" to exit the system in case of a lock-out. Do not use "CTRL C".

   - Use "CTRL ALT DEL" to restart the system.

8. An InfoWindow Presentation System block diagram is included. If the system has to be moved, use this as a guide when reconnecting the components.

INFOWINDOW PRESENTATION SYSTEM


AUDIO
L
R
VIDEO
RS-232
INFOWINDOW DISPLAY
SONY VIDEODISC PLAYER
SYNC CABLE
RGB GRAPHICS CABLE
IEEE-488 CABLE
IBM PS/2 COMPUTER
A
B
C
D
20 MB HARD DISK
KEYBOARD

COMPUTER SPECIFICATIONS

640 KB RAM
20 MB HARD DRIVE
A. INFOWINDOW EGA CARD
B. EXPANDED GRAPHICS MEMORY
C. GPIB ADAPTER CARD
D. GPIB INTERFACE CARD

SOFTWARE

1) INFOWINDOW PRESENTATION SYSTEM EDITOR
2) INFOWINDOW PRESENTATION SYSTEM INTERPRETER
3) INFOWINDOW CONTROL PROGRAM
4) IBM DOS 4.0

PERIPHERALS

INFOWINDOW DISPLAY MONITOR WITH TOUCH SCREEN
SONY LDP-1500 VIDEODISC PLAYER

KA-0V21-0KSK13

DISCREPANCY REPORTS

Fill out a discrepancy report if you find:

- A step that tells you the wrong thing to do.
- A step that is missing.
- A step that is confusing.
- A typographical error, or wrong terminology.
- You have have a better idea or a suggestion.

To fill out a discrepancy report:

- Fill in boxes 1 - 8, the designers will fill in the rest.
- Reference the number in the upper right-hand corner for box # 4.
- Give the filled out form to your manager to retain.
- The name and phone number section is for the designers to contact you, if necessary, for help making changes.
- Please describe any problems as clearly as possible. Use a seperate piece of paper if need be, but please attach it to the form.
- Use flow diagrams, sketches or other documentation wherever possible.

A sample Discrepancy Report form is included. Obtain them from your manager.

REACTION SURVEYS

Grumman management and the designers of this system would like to get a feel for the users reaction to this system. It will help them decide how to make improvements to the existing system. It will also help them decide whether other systems should be developed. Please fill out the survey forms and return them to your manager. Please be honest, it will not help if you are not.

A sample Reaction Survey form is included. Obtain them from your manager.

DISCREPANCY REPORT

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME:	2. DATE:	3. PHONE:	REPORT NO.:

4. STEP NUMBER:	5. STEP DESCRIPTION:

PROBLEM DESCRIPTION

6. CHECK BOX
- ☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
- ☐ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
- ☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
- ☐ MINOR: TYPOGRAPHIC, ETC.
- ☐ SUGGESTION

7. DESCRIBE PROBLEM:

RECOMMENDED SOLUTION

8.

ANALYSIS

MATERIALS AFFECTED

- ☐ STEP LIST
- ☐ TRAINING
- ☐ JOB AID
- ☐ USER GUIDE
- ☐ VIDEODISC
- ☐ OTHER (SPECIFY) ____________________
  ____

☐ STEP LIST ________

OUTLINE	IWPS CODE
☐ TRAINING ________	☐ TRAINING ________
☐ JOB AID ________	☐ OUTLINE ________

ACTION TAKEN:

RECEIVED BY:	DATE:	COMPLETED BY:	DATE:
ASSIGNED TO:	DATE:	REVIEWED BY:	DATE:

KA-BV25-DISK13

Evaluation Survey

The purpose of this survey is to help the developers pinpoint the strengths and weaknesses of the training module and job aid.

Your input will be used to determine what changes should be made to improve the system, please be honest.

You are encouraged to add any comments you wish.

Your name is not necessary but you may include it if you choose.

A. First we would appreciate a bit of information concerning your background and experience.

1. **Employer Description** (Circle one).

Grumman ESD   Grumman Tech Services   IBM   Other

2. What is your job title?

3. How long have you worked on e-beam or related systems?

4. What is your area of specialization?

5. How did you receive your training in your area of specialization? (circle all that apply).

a. Formal Education   Degree(s):

b. Classroom training by employer.

If so, what media were used? Slides   Videotape   Film

Lectures   Audio Cassettes   Text/Workbook

c. On-the-job-training.

d. Other. (Please describe)

B. The next group of questions are about your reaction to the computer-based training module and job aid. Circle answers.

6. Do you feel that a system like this would have helped you to learn your area of specialization?

Y or N

7. Would you recommend to management the development of training such as this for your area of specialization?

Y or N

8. Do you feel that a job aid such as this would in any way threaten your job security?

Y or N

If so, how?

9. Would you be willing to participate as a Subject Matter Expert in the development of a similar job aid for your area of specialization?

Y or N

C. A few of the main features of the system are listed below. Rate each feature by circling a number on the scale provided.

10. What was your opinion of the simulation of the ABF keypad.

Did not like   No opinion   Liked very much

5   4   3   2   1

11. How helpful to you would a simulator have been when you were learning your job?

Not at all helpful   Somewhat helpful   Very helpful

5   4   3   2   1

12. What was your opinion of the computer graphic representations of the beam.

Did not like   No opinion   Liked very much

5   4   3   2   1

13. How helpful to you would graphics or animations have been to you when you learned your job?

Not at all helpful.		Somewhat helpful.		Very helpful.
5	4	3	2	1

14. What was your opinion of the computer-based job aid?

Did not like		No opinion		Liked very much
5	4	3	2	1

15. How helpful would a written description of the steps involved in your job tasks be to you?

Not at all helpful.		Somewhat helpful.		Very helpful.
5	4	3	2	1

16. What was your opinion of the waveforms on the videodisc?

Did not like		No opinion		Liked very much
5	4	3	2	1

17. How helpful would a visual reference, such as the waveforms, be to you to for your job?

Not at all helpful.		Somewhat helpful.		Very helpful.
5	4	3	2	1

18. Do you ever find that a you forget how to perform procedures that you once knew?

Y or N

19. How helpful would a job aid (like this one) be to help you recall procedures that you had previously learned?

Not at all helpful.		Somewhat helpful.		Very helpful.
5	4	3	2	1

20. How helpful would an EL-3 simulator be to help you maintain the proficiency of your job skills?

Not at all helpful.		Somewhat helpful.		Very helpful.
5	4	3	2	1

Thank you for your participation.

This page can be used for any further comments or suggestions.

If you have an idea for something that could be implemented with a system like this for your job please describe it here.

APPENDIX L

RESULTS OF FIELD TRIALS

EVALUATION FORM

Learning Objective: 3.1 Description: ALIGN 1ST APERTURE

Trial #	Pass	Fail	Comments
1	X		
2		⊗	NOT CRITICAL!! (SEE BELOW)
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

STEP 3.1.3.1 SHOULD FOLLOW 3.1.2.5

USER SHOULD PRESS "ENTER" TO STORE VALUES DISPLAYED

STEPS APPEAR IN CORRECT ORDER,
BUT USER TOUCHES, NEXT MENU SELECTION
BEFORE PERFORMING - COULD LEAD TO
A PROBLEM!

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME: BOB VonDerLinn
2. DATE:
3. PHONE: ——
REPORT NO.: 01

4. STEP NUMBER: 3.1.3.1
5. STEP DESCRIPTION: PRESS ENTER

PROBLEM DESCRIPTION

6. CHECK BOX
- ☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
- ☐ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
- ☒ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
- ☐ MINOR: TYPOGRAPHIC, ETC.
- ☐ SUGGESTION

7. DESCRIBE PROBLEM:
USER SETS 2ND ALIGNMENT TO ONE SIDE (3.1.2.5) THEN BEGINS 3.1.3 ADJUST 1ST ALIGNMENT. USER SHOULD BE DIRECTED TO PRESS "ENTER" (3.1.3.1) IMMEDIATELY AFTER 3.1.2.5 to STORE DISPLAYED VALUES.

RECOMMENDED SOLUTION

8. INCLUDE DIRECTIONS TO PRESS ENTER IMMEDIATELY AFTER "MINIMIZE" OR "MAXIMIZE"

ANALYSIS

THE SAME CHANGE SHOULD BE MADE THROUGHOUT THE ENTIRE JOB AID.

MATERIALS AFFECTED

- ☒ VISUAL
- ☐ PARTICIPANT GUIDE
- ☐ INSTRUCTOR GUIDE
- ☐ OTHER (SPECIFY)

— TRAINING MODULE
– TASK LIST
– JOB AID

ACTION TAKEN:

TRAINING MODULE MODIFIED: [redacted] FEB 1, 90

RECEIVED BY: DATE:
ASSIGNED TO: DATE:
COMPLETED BY: DATE:
REVIEWED BY: DATE:

KA-BV25-DISK13

EVALUATION FORM

Learning Objective: 3.2 Description: ALIGN 2ND APERTURE

Trial #	Pass	Fail	Comments
1	X		
2	X		
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

SEE DISCREPANCY REPORT 01

EVALUATION FORM

Learning Objective: 3.3 Description: ALIGN 3RD APERTURE

Trial #	Pass	Fail	Comments
1	X		
2	X		
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

SEE DISCREPANCY REPORT 01

EVALUATION FORM

Learning Objective: 3.3.3 Description: DITHER X/Y

Trial #	Pass	Fail	Comments
1		X	
2	X		
3		X	
4		X	
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

- WAVEFORM NOT AVAILABLE
- MUST CHANGE REFERENCE FROM WAVEFORM TO DVM INDICATION

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME: R. VonDerLinn	2. DATE:	3. PHONE:	REPORT NO.: 02
4. STEP NUMBER: 3-3.3.1-6	5. STEP DESCRIPTION: USE H+V ARROW TO SEE WAVEFORM		

PROBLEM DESCRIPTION

6. CHECK BOX
- ☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
- ☒ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
- ☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
- ☐ MINOR: TYPOGRAPHIC, ETC.
- ☐ SUGGESTION

7. DESCRIBE PROBLEM:

WAVEFORM IS NOT AVAILABLE ON DISC. DVM INDICATION NOT DESCRIBED.

RECOMMENDED SOLUTION

8. CHANGE FROM "UNTIL WAVEFORM IS VISIBLE" TO: "until analog ammeter deflects down"

ANALYSIS

3-3-3-2-6 HAS THE SAME ERROR

MATERIALS AFFECTED

- ☒ VISUAL
- ☐ PARTICIPANT GUIDE
- ☐ INSTRUCTOR GUIDE
- ☐ OTHER (SPECIFY) – JOB AID – TASK LIST

ACTION TAKEN:

RECEIVED BY: DATE:

ASSIGNED TO: DATE:

COMPLETED BY: DATE:

REVIEWED BY: DATE:

KA-BV25-DISK13

EVALUATION FORM

Learning Objective: 3.4 Description: ALIGN SAMPLE APERTURE

Trial #	Pass	Fail	Comments
1	X		
2	X		
3		X	WHAT IF COARSE ADJUST?
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

IF USER SELECTS "COARSE" (PRESSES "C")

- HOW DOES HE RETURN TO FINE ADJUST?
- WHEN IS COARSE REQUIRED?

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME: BOB VANDERLAAN	2. DATE:	3. PHONE:	REPORT NO.: 03
4. STEP NUMBER: 3.4.2.4	5. STEP DESCRIPTION: IF COARSE ADJUST REQUIRED PRESS "C"		

PROBLEM DESCRIPTION

6. CHECK BOX

☐ CRITICAL: TEACHES ERRONEOUS CONTENT.

☒ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.

☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.

☐ MINOR: TYPOGRAPHIC, ETC.

☐ SUGGESTION

7. DESCRIBE PROBLEM:

- WHEN SHOULD USER PRESS "C"?
  I.E. WHEN IS COARSE ADJUST REQUIRED.
- HOW DOES USER RETURN TO "FINE" ADJUST?

RECOMMENDED SOLUTION

8. INCLUDE NEW CRITERIA FOR "REASONS TO USE COARSE ADJUST" INCLUDE DIRECTIONS FOR RETURNING TO "FINE ADJUST"

ANALYSIS

OCCURS IN OTHER PLACES IN JOB AID (TBD)

MATERIALS AFFECTED

☒ VISUAL

☐ PARTICIPANT GUIDE

☐ INSTRUCTOR GUIDE

☐ OTHER (SPECIFY)
- JOB AID
- TASK LIST

ACTION TAKEN:

RECEIVED BY:	DATE:	COMPLETED BY:	DATE:
ASSIGNED TO:	DATE:	REVIEWED BY:	DATE:

KA-BV25-DISK13

EVALUATION FORM

Learning Objective: 3.5 Description: GET FILAMENT PROFILE

Trial #	Pass	Fail	Comments
1		X	
2		X	
3		X	
4		X	
5		X	

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

WAVEFORMS NOT AVAILABLE CURRENTLY
THEY ARE ON DISC.!!!

WRITTEN DESCRIPTION NOT SUFFICIENT

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME: BOB VONDERLINN	2. DATE:	3. PHONE:	REPORT NO.: 04
4. STEP NUMBER: 3.5.2	5. STEP DESCRIPTION: OBSERVE WAVEFORMS		

PROBLEM DESCRIPTION

6. CHECK BOX
- ☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
- ☒ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
- ☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
- ☐ MINOR: TYPOGRAPHIC, ETC.
- ☐ SUGGESTION

7. DESCRIBE PROBLEM: WAVEFORMS NOT INCORPORATED INTO JOB AID

RECOMMENDED SOLUTION

8. RE-DO SEGMENT ON "OBSERVE WAVEFORMS" TO INCLUDE BEAM PROFILE WAVEFORMS.

ANALYSIS

MATERIALS AFFECTED

- ☑ VISUAL
- ☐ PARTICIPANT GUIDE
- ☐ INSTRUCTOR GUIDE
- ☐ OTHER (SPECIFY) - JOB AID

ACTION TAKEN:

RECEIVED BY:	DATE:	COMPLETED BY:	DATE:
ASSIGNED TO:	DATE:	REVIEWED BY:	DATE:

KA-BV25-DISK13

EVALUATION FORM

Learning Objective: 3.6 Description: CHECK FARADAY CUP

Trial #	Pass	Fail	Comments
1	X		
2	X		
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

EVALUATION FORM

Learning Objective: 3.8 Description: CHECK TARGET SETTING

Trial #	Pass	Fail	Comments
1	X		
2	X		
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

O.K. But touches could be eliminated

See DISCREPANCY REPORT 05

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME: BOB VanDerLinn	**2. DATE:**	**3. PHONE:**	**REPORT NO.:** 05
4. STEP NUMBER: 3.8.1	**5. STEP DESCRIPTION:** TURN SERVOS OFF		

PROBLEM DESCRIPTION

6. CHECK BOX

- ☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
- ☐ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
- ☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
- ☐ MINOR: TYPOGRAPHIC, ETC.
- ☒ SUGGESTION

7. DESCRIBE PROBLEM:

TOO MANY TOUCHES TO GET TO INFO

RECOMMENDED SOLUTION

8. WHEN USER TOUCHES MENU SELECTION, "TURN SERVOS OFF" – SHOULD BRANCH DIRECTLY TO VIDEO GRAPHIC.

ANALYSIS

MATERIALS AFFECTED

- ☒ VISUAL
- ☐ PARTICIPANT GUIDE
- ☐ INSTRUCTOR GUIDE
- ☐ OTHER (SPECIFY) JOB AID

ACTION TAKEN:

RECEIVED BY:	DATE:	COMPLETED BY:	DATE:
ASSIGNED TO:	DATE:	REVIEWED BY:	DATE:

EVALUATION FORM

Learning Objective: 3.11 Description: ______________________

Trial #	Pass	Fail	Comments
1		X	
2		X	
3		X	
4		X	
5		X	

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

STEPS MISSING

Discrepancy Report

DIRECTIONS:
- FILL IN BOXES 1 – 8
- SUBMIT TO MANAGER

1. NAME:	2. DATE:	3. PHONE:	REPORT NO.: 06
4. STEP NUMBER: 3.11.??	5. STEP DESCRIPTION: ADJUST HEATER/EMISSION		

PROBLEM DESCRIPTION

6. CHECK BOX

☐ CRITICAL: TEACHES ERRONEOUS CONTENT.
☒ SERIOUS: FAILS TO TEACH REQUIRED CONTENT.
☐ CONFUSING: CONTENT NOT ORGANIZED/ EXPLAINED CLEARLY.
☐ MINOR: TYPOGRAPHIC, ETC.
☐ SUGGESTION

7. DESCRIBE PROBLEM:

STEPS MISSING .

RECOMMENDED SOLUTION

8. - TALK TO BOB KANE ON PHIL -

ANALYSIS

MATERIALS AFFECTED

☒ VISUAL
☐ PARTICIPANT GUIDE
☐ INSTRUCTOR GUIDE
☐ OTHER (SPECIFY)

TASK LIST
JOB AID

ACTION TAKEN:

RECEIVED BY: DATE:
ASSIGNED TO: DATE:
COMPLETED BY: DATE:
REVIEWED BY: DATE:

KA-BV25-DISK13

EVALUATION FORM

Learning Objective: 3.12 Description: REPLACE FILAMENT

Trial #	Pass	Fail	Comments
1	X		
2	X		
3	X		
4	X		
5	X		

If a fail is given for any trial, describe the problem that caused the failure below. Include an estimate of the effort necessary to resolve the problem.

GOOD - THEY SHOULD ALL BE LIKE THAT!

APPENDIX M

RESULTS OF REACTION SURVEY

Results of Evaluation Survey

1. Employer Description (Circle one).

Grumman ESD	Grumman Tech Services	IBM	Other
(6)	(1)	(0)	(0)

2. What is your job title?
   - (3) Electronic Technician
   - (2) Mechanical Engineer
   - (2) Electrical Engineer

3. How long have you worked on e-beam or related systems?
   8, 2.5, 4, 9, 10, 11, 8 years

4. What is your area of specialization?
   - (3) Technical Support
   - (2) Mechanical Subsystems
   - (1) Analog Subsystems
   - (1) Digital Subsystems

5. How did you receive your training in your area of specialization? (circle all that apply).

   a. Formal Education (3) Degree(s): (1) BSME (2) BSEE

   b. Classroom training by employer. (2)

   If so, what media were used? Slides Videotape Film

   Lectures (2) Audio Cassettes Text/Workbook (3)

   c. On-the-job-training. (6)

   d. Other. (Please describe)
   (1) Classroom Training by Customer.

6. Do you feel that a system like this would have helped you to learn your area of specialization?
   Y (7) or N (0)

7. Would you recommend to management the development of training such as this for your area of specialization?
   Y (6) or N (0)

8. Do you feel that a job aid such as this would in any way threaten your job security?
   Y (0) or N (8)

9. Would you be willing to participate as a Subject Matter Expert in the development of a similar job aid for your area of specialization?
   Y (5) or N (2)

10. What was your opinion of the simulation of the ABF keypad.

Did not like No opinion Liked very much

5 (0) 4 (0) 3 (0) 2 (5) 1 (2)

11. How helpful to you would a simulator have been when you were learning your job?

Not at all helpful Somewhat helpful Very helpful

5 (0) 4 (0) 3 (2) 2 (2) 1 (3)

12. What was your opinion of the computer graphic representations of the beam.

Did not like No opinion Liked very much

5 (0) 4 (0) 3 (1) 2 (2) 1 (4)

13. How helpful to you would graphics or animations have been to you when you learned your job?

Not at all helpful. Somewhat helpful. Very helpful.

5 (0) 4 (1) 3 (1) 2 (2) 1 (3)

14. What was your opinion of the computer-based job aid?

Did not like No opinion Liked very much

5 (0) 4 (0) 3 (1) 2 (2) 1 (4)

15. How helpful would a written description of the steps involved in your job tasks be to you?

Not at all helpful. Somewhat helpful. Very helpful.

5 (0) 4 (0) 3 (2) 2 (1) 1 (4)

16. What was your opinion of the waveforms on the videodisc?

Did not like No opinion Liked very much

5 (0) 4 (0) 3 (1) 2 (0) 1 (2)

17. How helpful would a visual reference, such as the waveforms, be to you to for your job?

Not at all helpful.		Somewhat helpful.		Very helpful.
5 (0)	4 (0)	3 (1)	2 (1)	1 (4)

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